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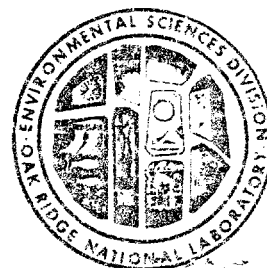
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Sediment Contamination in Streams Surrounding the Oak Ridge Gaseous Diffusion Plant

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I. L. Larsen
P. D. Lowry

Environmental Sciences Division
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ENVIRONMENTAL SCIENCES DIVISION

SEDIMENT CONTAMINATION IN STREAMS SURROUNDING THE
OAK RIDGE GASEOUS DIFFUSION PLANT

T. L. Ashwood, C. R. Olsen, I. L. Larsen, and P. D. Lowry

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CONTENTS

	<u>Page</u>
LIST OF FIGURES	v
LIST OF TABLES	vii
EXECUTIVE SUMMARY	ix
1. Introduction	1
2. Methodology	3
2.1 Sample Collection	3
2.2 Radionuclide Analysis	5
2.3 Elemental and Organic Analyses	9
2.3.1 Sample Preparation and Analysis	9
2.3.2 Calibration and Quality Control	10
3. RESULTS AND DISCUSSION	14
3.1 Sediment Grab Samples	14
3.2 Sediment Cores	22
4. SUMMARY AND CONCLUSIONS	29
5. ACKNOWLEDGMENTS	30
6. REFERENCES	31
APPENDICES	33
A. Sample Locations	A-1
B. Radioisotopes	B-1
C. ICP and Mercury Data	C-1
D. Organics	D-1
E. Sediment Core Data	E-1

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	Map indicating primary sampling areas	4
2	Radionuclide, organic and metal profiles in sediment cores	23

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Radionuclide decay properties used in analysis	7
2	Comparison of analysis of uranium samples with certified values ($\text{pCi/g} \pm 1 \sigma$)	7
3	Comparison of analysis with certified reference materials	8
4	Estimated minimum-detectable activity levels for a 100-min counting interval	8
5	Analytical results for National Bureau of Standards (NBS) samples (concentrations in $\mu\text{g/g}$)	11
6	Duplicate analytical results for metals	11
7	Organic - Typical control data from USEPA environmental monitoring and support lab - Cincinnati (Samples WP-482 and WP-881 Received 7/26/85)	12
8	Summary of contaminant levels	13
9	Areas of metal contamination exceeding 150% of K-25 mean .	16
10	Areas of organics contamination exceeding 1 $\mu\text{g/g}$ or 150% of K-25 mean	17
11	Areas with radioisotope levels exceeding 150% of K-25 mean	18

EXECUTIVE SUMMARY

Approximately 180 surface-sediment grab samples and three sediment cores were obtained from the Clinch River-Poplar Creek system around the Oak Ridge Gaseous Diffusion Plant (K-25) and screened for metal, organic, and radioisotope contamination. The results of this scoping study were evaluated to identify potential sources of contamination.

Data from this study indicate that Hg, ^{137}Cs , and ^{60}Co originate from sources outside K-25. External sources also contribute uranium and miscellaneous organic contamination. Within K-25, the K1700 stream, K901A chromate pond, K710A powerhouse, and K1007B pond appear to be the major areas of contamination. Principal contaminants detected in these areas as a result of this survey were U, Cr, Ni, Cu, Ag, and PCBs.

Although the major areas of contamination have been identified, this report does not attempt to identify the specific sources within K-25 nor to quantify the impact of K-25 sources on the major streams.

1. INTRODUCTION

The Oak Ridge Gaseous Diffusion Plant (K-25) is one of three large, industrial facilities located on the Oak Ridge Reservation. K-25 has been involved in the production of enriched uranium since 1944. Supporting the uranium enrichment operation are chemical process facilities, research and development laboratories, and a large maintenance force. The support activities generate a wide spectrum of wastes, including metals and organic compounds. These wastes have been generated, stored, and disposed of in several areas around the plant.

A survey of sediments in the streams surrounding the K-25 plant has been conducted to identify sites from which pollutants have historically entered or may currently be entering the surface water. Previous studies (DOE 1979; Hoffman et al. 1984) have attempted to address the general extent of sediment contamination around K-25 and the Oak Ridge Reservation. This study identifies areas surrounding the K-25 site where contaminant levels are high enough to indicate the possible presence of a contamination source--for example, seepage from a surface impoundment. Results from this survey may be used in conjunction with groundwater monitoring data and information on current and historic waste management practices to identify specific sources of contamination.

Due to the absence of established standards for contaminant levels in sediments, no attempt is made in this study to characterize any areas as being hazardous.

From January 10, 1985, through February 28, 1985, approximately 180 surface-sediment grab samples and three sediment cores were collected in the Clinch River-Poplar Creek system and several ponds, discharge pipes, and ephemeral streams on the K-25 site. Every effort was made to obtain samples of recently deposited material, so that the results would indicate current conditions at the plant. The presence of ^7Be (a naturally-occurring, 53-d half life radionuclide) was used to indicate whether the samples were of recent origin.

The K-25 Process Support Department screened the samples for metals using inductively coupled plasma spectroscopy (ICP), for PCBs using gas chromatography (GC), and for other organics using a gas chromatograph-mass spectrometer (GC-MS). The samples were also analyzed for gamma-emitting radioisotopes by the ORNL Environmental Sciences Division.

Results of this study are presented in two parts. The first part, consisting of results from the 180 grab samples, yields a picture of current contaminant levels around the K-25 site. The second part, which addresses the three cores, presents a historical perspective of sediment contamination around K-25.

2. METHODOLOGY

2.1 SAMPLE COLLECTION

Surface (fine-grained) sediment samples were collected during January and February 1985 in the Clinch River, Poplar Creek, and tributaries draining K-25. The Clinch River sampling was in the vicinity of the K-1515 sludge treatment pond, K-710A scrap yard, and K-901A holding pond (Fig. 1). Poplar Creek was sampled from its confluence with the Clinch River to about 1 km upstream of the mouth of East Fork Poplar Creek. Several samples were also collected from East Fork Poplar Creek. Sampling along Poplar Creek and its tributaries was intensified near all water effluent sites and surrounding disposal areas (Fig. 1). Particular attention was given to the K-1700 stream, which drains areas near the K-1407 holding ponds, coal pile, and the classified burial ground.

The fine-grained sediment sample collected at each site was split into two subsamples. One was hermetically sealed in a 100 cm³ aluminum can (plastic lined), and the other subsample was homogenized and placed in a 225 cm³ (8 oz.) glass jar, sealed with teflon and aluminum foil. Two sediment cores were also collected at each of three sites, using a vibracorer (Lanesky et al. 1979) equipped with a 7.6-cm (3-in.) diam aluminum core pipe. One of the core sites was at the confluence of East Fork Poplar Creek into Poplar Creek (upstream of the K-25 facilities but downstream of the Y-12 Plant and the city of Oak Ridge). The second core site was in lower Poplar Creek near its mouth into the Clinch River (downstream of most K-25 facilities). The

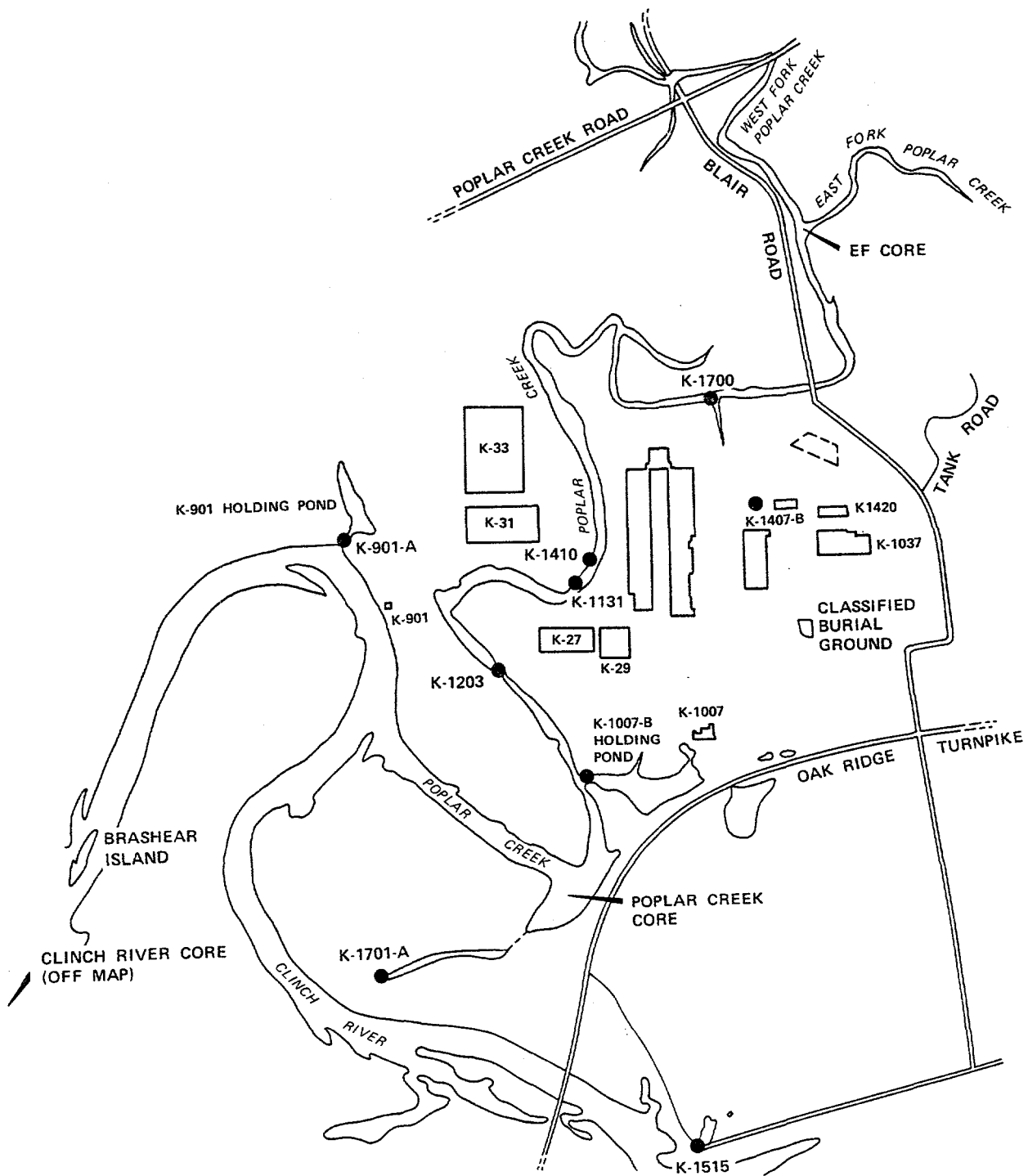


Fig. 1. Map indicating primary sampling areas

third site was in a sediment accumulation zone where the Clinch River widens into Watts Bar Lake.

One of the two cores collected at each site, was sectioned into 2-cm increments in the first 40 cm of the core and into 4-cm increments below 40 cm. These cores were used to determine the vertical distribution of radionuclides and develop a sediment chronology. The second core from each site was sectioned into 4-cm intervals above 80 cm and into 8-cm intervals below 80 cm, to provide enough sedimentary material for the metal and organic analyses. A comparison of the sedimentary structures and characteristics in the two cores during extrusion indicated that both cores could be considered duplicates at the East Fork Poplar Creek and Watts Bar Reservoir sites but not at the Lower Poplar Creek site. Consequently, both cores at the Lower Poplar Creek site were analyzed for gamma-emitting radionuclides.

2.2 RADIONUCLIDE ANALYSIS

Radioactivity analysis was accomplished by gamma-ray spectrometry, using either Ge(Li) or intrinsic germanium detectors. Calibration of the detectors has been previously described by Larsen and Cutshall (1981). The canned samples were counted for a period of typically 100 min using a Nuclear Data 6700 microprocessor system to acquire and store accumulated counts in 4096 channels. A modified Nuclear Data software program allows for an automated peak search routine to be performed, corrects for the presence of any background contributions (Cutshall and Larsen 1980), identifies radionuclides by their gamma-ray

signature, performs activity calculations, and corrects for decay based on the elapsed time interval between the sample collection and sample analysis dates. A hard copy printout of the data was made for each sample analyzed.

Following radioactivity analysis, each sample was air dried at $\sim 72^{\circ}\text{C}$ for over 48 h. Radioisotope activity levels were then calculated based on dry sample weight.

Table 1 provides data for the specific radionuclides of interest. For comparison, Tables 2 and 3 illustrate radioactivity analyses performed on certified reference materials. The concentrations are corrected for decay to the date of assay.

Due to low uranium activity in many of the samples, the relatively short counting time, as well as the low photon abundance accompanying the photon decay of uranium, the lower levels of detection may not be achieved, and in such instances, a relatively large analytical uncertainty exists. For ^{235}U values to be considered present, at least 2 of the 3 photon peaks listed in Table 1 had to be reported on the hard copy data sheet. Minimum-detectable-activity levels (Pasternak and Harley 1971) for the various radionuclides are presented in Table 4. If any of these quantities of radioactive material were present in the samples when counted for 100 min, then 95% of the time a value greater than zero would be reported for these radionuclides. However, at these low activity levels, the relative analytical uncertainty may range from ± 40 to 100% of the value. The minimum-detectable activity depends upon matrix composition (i.e., other radionuclides present and their amount), the sample size,

Table 1. Radionuclide decay properties used in analysis

Isotope	Photon energy (KEV)	Photon abundance (%)	Half-life
^7Be	477.6	10.3	53.3 d
^{137}Cs	661.6	85.1	30.17 years.
^{60}Co	1173.2	99.9	5.27 years.
	1332.5	100.0	
^{235}U	143.8	10.5	7.04E8 years.
	163.4	4.7	
	205.3	4.7	
$^{238}\text{U}(\text{as } ^{234\text{m}}\text{Pa})^a$	1001	0.92	4.47E9 years.

^aDaughter radionuclide of ^{238}U , assumed to be in equilibrium.

Table 2. Comparison of analysis of uranium samples with certified values ($\text{pCi/g} \pm 1 \sigma$)

Sample (a)	Radioisotope	Measured	Certified
NBL-76B	^{238}U @1001	38.8 ± 3.5	33.7 ± 0.3
^{235}U @143	2.6 ± 0.2	$(1.6)^a$	
@163	1.6 ± 0.3		
@205	1.6 ± 0.3		
CCRM-BL1	^{238}U @1001	76 ± 12	75 ± 2
^{235}U @143	5.2 ± 0.7	$(3.4)^a$	
@163	4.3 ± 1.3		
@205	5.4 ± 1.3		
CCRM-DL1	^{238}U @1001	17.4 ± 2.6	13.7 ± 0.5
^{235}U @143	0.9 ± 0.1	$(0.6)^a$	
@163	0.7 ± 0.2		
@205	ND		
CCRM-BL4A	^{238}U @1001	402 ± 29	419 ± 11
^{235}U @143	24.0 ± 1.6	$(19.3)^a$	
@163	16.3 ± 3.0		
@205	19.6 ± 3.0		

^aBased on an activity ratio of $^{235}\text{U}/^{238}\text{U} = 4.60\%$.

NBL: New Brunswick Laboratory, Argonne National Lab., Ill.

CCRM: Canadian Certified Reference Material, Canada Centre for Mineral and Energy Technology, Ottawa, Canada.

ND: Not detected.

Table 3. Comparison of analysis with certified reference materials
(pCi/g $\pm 1 \sigma$)

Sample		Cs-137	K-40	Ac-228
Rocky Flats Soil #1 NBS SRM 4353 (Assay date: 15 Dec 80)	Measured	0.49 ± 0.02	19.2 ± 0.1	1.93 ± 0.08
	Expected	0.48 ± 0.01	19.5 ± 0.6	1.89 ± 0.03
		Cs-137	Co-60	
IAEA Marine sediment SD-N-1 (Assay date: 1 Jan 82)	Measured	0.396 ± 0.018	0.312 ± 0.029	
	Expected	0.378 ± 0.012	0.319 ± 0.012	

Table 4. Estimated minimum-detectable activity
levels for a 100-min counting interval

Radionuclide	MDA pCi	Concentration for an 80-g dry wt sample (pCi/g)
^7Be	18	0.2
^{137}Cs	3	0.04
^{60}Co	3	0.04
^{235}U	16	0.20
^{238}U	220	2.8

counting time, detector efficiency, geometry, and any background contributions. Thus the values reported in Table 4 should not be considered absolutes but may range by several factors, depending on the above conditions. Their purpose is to provide a general level of sensitivity expected from a typical 100-min count.

2.3 ELEMENTAL AND ORGANIC ANALYSES

2.3.1 Sample Preparation and Analysis

For organic analysis, wet subsamples of the refrigerated samples were extracted using methylene chloride and scanned for PCBs and insecticides using GC. Selected samples were further analyzed by GC-MS using a Hewlett-Packard HP 5985-B. Organic priority pollutants were identified and quantified using computer-assisted software coupled with spiked internal standards in each sample.

Elemental analysis (except for mercury) was performed by emission spectroscopy, using a Jarrel-Ash ICP 9000 spectrophotometer.

Approximately 10 g of dried material was placed in a 50 cm³ plastic jar along with a pea-sized plastic impact bead and shaken vigorously for several hours to pulverize the dried sample. One gram of this material was then digested using EPA Method 3050. For the elements Ag, Sb, and Sn, a diluted form of "aqua regia" was used, and for the other elements, a 2% nitric acid solution along with hydrogen peroxide was used. Following digestion, the samples were filtered through #42 Whatman filter paper, and the residue on the filter was discarded. Reagent solutions were treated similarly to determine blank contributions. The analyte solution was then transferred to 100-mL containers and diluted with a 10% nitric acid solution.

Mercury was analyzed by the EPA Method 7470, using a Fisher Atomic Absorption (AA) instrument dedicated exclusively to this analysis.

2.3.2 Calibration and Quality Control

Certified solutions of various elements of "Spex standards" were prepared and appropriately diluted using a 10% nitric acid for ICP analysis. A linear calibration of up to a 500-ppm concentration for various elements was performed. Sample concentrations determined beyond this range were verified using a higher concentration of standards when necessary. Table 8 (see Sect. 3.1) lists the lower detection limits expected from this type of analysis. Typical ICP accuracy from aqueous samples is $\pm 20\%$ at the 2-sigma level. Quality assurance is regularly performed using an Environmental Research Associates waste water intracalibration solution. For this study, samples of National Bureau of Standards River sediment (1645 and 1646) were submitted and run. Results are illustrated in Table 5. Mercury quality assurance analysis was routinely performed by analysis of an NBS certified solution #1641B. Table 6 presents a comparison of results from duplicate analyses.

Calibration for organic analysis was performed daily using quality assurance standards from the EPA. Routine analyses of quality assurance solutions are performed monthly. Table 7 compares typical values determined by K-25 with the expected concentrations. Limits of detection for priority pollutants are given in Table 8 (see Sect. 3.1). Organics not analyzed for but, in many instances, present include light and heavy hydrocarbons.

Table 5. Analytical results for National Bureau of Standards (NBS)
Samples (concentrations in $\mu\text{g/g}$)

Element	NBS 1645 River sediment			NBS 1646 Estuarine sediment		
	Std.	Prep No.1	Prep No.2 ^a	Std.	Prep No.1	Prep No. 2
Arsenic(As)	(66) ^b	60	60	11.6	22.3	27.5
Cadmium(Cd)	10.2	8.3	7.6	0.4	0.7	0.5
Chromium(Cr)	29600	26300	27200	76	40.9	52.1
Copper(Cu)	109	106	112	18	16.3	15.6
Nickel(Ni)	45.8	41.3	50.9	32	24.5	27.5
Lead(Pb)	714	650	658	28.2	22.3	22.4
Selenium(Se)	(1.5)	NR ^c	NR	(0.6)	<5	<5
Zinc(Zn)	1720	1490	1510	138	109	115

^aPrep #2 is a duplicate of Prep #1. Both preparations followed EPA procedure 3050.

^bNumbers in parentheses are noncertified results.

^cNR means value was not reported.

Table 6. Duplicate analytical results for metals

Element	Number of duplicates ^a	Sample mean ($\mu\text{g/g}$)	Duplicate mean ($\mu\text{g/g}$)
Silver (Ag)	3	5.0	4.9
Arsenic (As)	1	9.6	5.6
Cadmium (Cd)	0		
Chromium (Cr) ^b	4	36.8	36.5
Copper (Cu)	4	30.5	31.2
Mercury (Hg)	3	3.8	3.7
Nickel (Ni)	5	42.0	40.8
Lead (Pb)	5	20.3	20.3
Selenium	5	142	140
Zinc (Zn)	5	138	126

^aIncludes only those samples for which a given element was detected.

^bDoes not include sample/duplicate pair from K901A chromate pond. Results of this pair were 1400 $\mu\text{g/g}$ vs 1200 $\mu\text{g/g}$.

Table 7. Organic - Typical control data from USEPA
environmental monitoring and support lab - Cincinnati
(Samples WP-482 and WP-881 Received 7/26/85)

Component: WP-482 (base neutrals)	Measured conc. ($\mu\text{g/L}$)	Acceptable range ($\mu\text{g/L}$)	EPA certified value ($\mu\text{g/L}$)
1,4-Dichlorobenzene	16	(9-24)	24.8
Bis (2-chloroisopropyl) ether	29	(9-24)	38.8
Hexachloroethane	15	(9-24)	30.0
Nitrobenzene	52	(9-24)	76.5
Naphthalene	15	(9-24)	24.8
Dimethyl phthalate	13	(9-24)	40.0
Acenaphthylene	14	(9-23)	19.5
Fluorene	36	(9-23)	51.2
4-Chlorophenol phenyl ether	35	(9-23)	76.7
4-Bromophenyl phenyl ether	35	(9-23)	41.5
Anthracene	30	(9-23)	40.0
Fluoranthene	24	(9-23)	29.8
Butyl benzyl phthalate	12	(9-23)	51.3
Chrysene	23	(9-23)	69.9
Bis (2-ethylhexyl) phthalate	10	(9-23)	29.1
Benzo (b) fluoranthene	29	(9-23)	40.0
Benzo (a) pyrene	21	(9-23)	24.9
Dibenzo (a,h) anthracene	35	(9-23)	40.7
Benzo (g,h,i) perylene	76	(9-23)	80.4
Component: WP-881 (acids)	Measured conc. ($\mu\text{g/L}$)	Acceptable range ($\mu\text{g/L}$)	EPA certified value ($\mu\text{g/L}$)
2-Chlorophenol	29	(8.1-37)	30
2-Nitrophenol	29	(8.1-37)	50
Phenol	43	(12-89)	100
2,4-Dimethylphenol	21	(12-89)	30
2,4-Dichlorophenol	40	(12-89)	50
2,4,6-Trichlorophenol	19	(12-89)	25
4-Chloro-3-methylphenol	52	(17-73)	75
2-Methyl-4,6-dinitrophenol	210	(17-73)	250
Pentachlorophenol	32	(6.8-77)	75
4-Nitrophenol	7	(5-40)	50

Table 8. Summary of contaminant levels

Element/Compound	Detection limit ^a	No. of samples detected	K-25 Mean ^b	Maximum level	No. of high ^c samples
Silver(Ag)	0.6	29	8	89	4
Arsenic(As)	5.0	14	50	190	2
Cadmium(Cd)	0.3	13	2	5	2
Chromium(Cr)	1.0	51	69 ^d	3300	11
Copper(Cu)	0.4	51	94	470	12
Lead(Pb)	5.0	49	42	140	9
Mercury(Hg)	0.1	45	6	45	6
Nickel(Ni)	1.0	52	220	1300	13
Selenium(Se)	5.0	38	91	280	5
Zinc(Zn)	0.1	52	250	990	8
Total organic carbon		180	3	65	4
PCB 1254	1.0	5	7	13	1
PCB 1260	1.0	2	4	5	1
Acenaphthylene	0.004	7	<1	<1	0
Anthracene	0.002	11	<1	2	1
Benzo(a)Anthracene	0.008	3	1	2	1
Bis(2-ethylhexyl)phthalate	0.003	23	7	97	2
Chrysene	0.003	4	2	3	1
di-N-butylphthalate	0.003	19	<1	1	0
Fluoranthene	0.002	23	1	10	4
Phenanthrene	0.005	23	1	7	4
Pyrene	0.002	24	1	12	4
¹³⁷ Cesium	0.04	178	2	15	32
⁶⁰ Cobalt	0.04	111	<1	2	15
²³⁸ Uranium	2.8	40	30	254	8
²³⁵ Uranium	0.2	25	4	20	6

^aUnits of measurements are percentage for total organic carbon, $\mu\text{g/g}$ for metals and organics, and pCi/g for radioisotopes. All units are based on dry weight.

^bThe K-25 mean is calculated as the average level of those samples in which a particular element or compound was detected.

^c"High" is defined as 150% of the K-25 mean or $1\mu\text{g/g}$, whichever is greater. For total organic carbon, the threshold is 10%

^dThe K-25 mean for Cr does not include samples from the Chromate Pond.

3. RESULTS AND DISCUSSION

3.1 SEDIMENT GRAB SAMPLES

Table 8 presents a general summary of contaminant levels for the 182 sediment grab samples (including the top 4 cm of three cores). All 182 samples were analyzed for total organic carbon (TOC) screened for PCBs and counted for radioisotopes. Fifty-two samples were analyzed for metals by ICP and AA. Thirty-two samples were analyzed by GC-MS for extractable organics.

Although the ICP and GC-MS analyses cover a wide range of elements and compounds, this study focused on those contaminants identified by Hoffman et al. (1984, Table VII) as warranting further study on the Oak Ridge Reservation. Hoffman et al. (1984) made this determination based on those contaminants for which an estimated level of intake exceeded the estimated allowable daily intake and which were found in concentrations above minimum detectable limits. The organics list for this study was reduced further by elimination of those components which were not found at levels above detectable limits at K-25.

The K-25 mean for each contaminant represents the average level of all samples for which that contaminant was detected. For example, the K-25 silver mean was determined by averaging the silver content of the 29 samples in which silver was detected.

The K-25 mean provides a basis for determining which samples have relatively high levels of a particular contaminant. The K-25 mean, rather than the background level, is used because the objective is to determine which samples are high for K-25, not to determine which

samples are high relative to background. Using the K-25 mean facilitates identification of those areas around the K-25 site which may be sources of contamination.

The number of high samples is based on those samples which exceeded 150% of the mean. For some of the organics, 150% of the mean would still have been less than 1 ug/g, so the number of high samples was based on those exceeding 1 ug/g. For total organic carbon, the threshold was set at 10%. Tables 9, 10, and 11 respectively present the samples that were determined to be high for metals, organics, and radioisotopes. It must be remembered that this is purely an arbitrary designation to determine those areas that are potential sources of contamination. In the absence of definitive standards and further study, no statement can be made about the potential environmental effects, if any, of these contaminant levels. Following is a discussion, by area, of the grab sample results.

The K-901A chromate pond (Fig. 1 and Appendix A, p. A-13) sediments are high in chromium, as would be expected to result from the chromate wastes that have settled in this pond. The reason for the high zinc and selenium levels is not readily apparent, unless these elements are part of the proprietary formula of the chromate corrosion inhibitor used in the recirculating cooling water systems.

The samples identified in Table 9 as being from the Classified Burial Ground were actually taken from ephemeral streams on the north (42) and southeast (216) slopes of the burial ground hill (Fig. 1 and Appendix A, pp. A-4 and A-14). Sample 42 appears to be in the

Table 9. Areas of metal contamination exceeding 150% of K-25 mean

Area/sample No.	Metals (ug/g)									
	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
Chromate pond										
SS020785-124	<0.6	<5	<0.3	740	9	0.3	27	17	120	230
SS020785-125	<0.6	<5	<0.3	2800	28	<0.2	10	8	<5	990
SS020785-126	1.2	<5	<0.3	1600	8	0.6	5	8	<5	410
SS020785-127	<0.6	<5	<0.3	250	0	1.1	2	5	<5	350
SS020785-130	1.5	<5	<0.3	3300	8	0.6	6	5	<5	900
SS020885-132	1.8	<5	<0.3	410	5	<0.1	20	14	110	140
SS020885-133	<0.6	<5	<0.3	2100	17	0.9	26	16	88	560
SS020885-135	<0.6	9	<0.3	1600	26	0.8	39	24	110	230
Class. burial ground										
SS020485-42	23.0	<5	<0.3	66	77	1.4	83	77	58	230
SS022885-216	1.2	<5	<0.3	17	40	0.9	120	10	140	41
Clinch River Trib 1										
SS012485-10	<0.6	<5	<0.3	51	4	0.7	38	22	140	190
East Fork Poplar Creek										
SS022285-138	<0.6	<5	3.3	45	76	45.0	54	110	37	320
EF021585(0-4)	4.9	<5	<0.3	49	40	20.7	33	26	110	130
K1007B (PC Trib 4)										
SS020485-45	12.0	<5	<0.3	150	56	<0.5	89	47	38	210
SS020485-46	17.0	<5	1.0	63	63	<0.5	86	37	21	220
K1700 Stream										
SS020485-41R	<0.6	23	<0.3	39	250	<1.0	420	46	<5	160
SS020485-35L	<0.6	<5	<0.3	69	210	1.5	400	39	110	210
SS020485-34L	<0.6	15	<0.3	50	220	3.0	430	49	48	190
SS020485-33L	<0.6	34	1.3	62	230	1.8	460	48	<5	240
SS020485-32M	89.0	45	1.1	65	250	2.9	520	73	<5	220
SS020485-31R	<0.6	16	1.1	57	210	1.8	560	51	<5	240
SS011085-6L	1.8	22	0.8	130	300	6.6	830	140	57	410
SS011085-5R	2.5	190	<0.3	100	470	4.4	1200	100	280	450
SS020485-49	1.4	33	<0.3	91	250	2.1	1000	97	150	330
SS011085-4L	<0.6	170	4.6	98	440	4.6	950	120	<5	510
SS011085-3L	<0.6	68	2.4	91	260	6.1	1300	94	<5	350
SS011085-2L	1.4	45	2.2	88	260	6.1	1200	94	<5	370
SS011085-1L	<0.6	15	1.5	57	140	9.5	420	49	<5	220
Poplar Creek										
SS020685-52R	6.2	<5	2.0	67	78	25.6	44	43	72	200
SS020685-111R	<0.6	<5	<0.3	56	47	11.0	59	30	77	170
SS020785-86R	44.0	<5	<0.3	32	30	5.4	46	29	67	170
SS020785-120L	1.3	<5	<0.3	95	35	9.5	51	27	60	210
SS020785-115	<0.6	<5	<0.3	610	62	<0.5	68	48	45	590
SS021185-155R	2.6	<5	<0.3	46	41	7.7	60	20	160	150

Table 10. Areas of organics contamination exceeding 1 µg/g or 150% of K-25 mean

Area/sample No.	TOC ^a (%)	PCB 1254	PCB 1260	Organics ^b (µg/g)								
				2B	3B	5B	13B	18B	26B	31B	44B	45B
Chromate Pond												
SS020785-125	1.9	<1.0	<1.0	ND	ND	ND	2.9	ND	ND	1.6	1.1	1.4
East Fork Poplar Creek												
SS022285-138	3.9	<1.0	<1.0	ND	ND	1.3	4.7	1.9	ND	3.1	2.8	4.0
K1007B (PC Trib 4)												
SS020485-44	0.9	6.5	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
SS020485-45	ND	12.6	<1.0	0.7	ND	ND	0.5	0.5	0.2	0.9	0.3	1.2
SS020485-46	1.4	3.0	<1.0	0.2	ND	ND	ND	ND	ND	ND	ND	ND
SS020485-47	1.3	5.2	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
K1515												
SS013085-16	64.6	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
K1700 Stream												
SS020485-39L	12.4	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
SS020485-38R	11.4	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
SS020485-35L	4.6	<1.0	<1.0	ND	2.4	ND	ND	ND	0.1	3.0	2.4	2.5
SS020485-32M	16.2	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
SS011085-5R	7.3	ND	ND	ND	0.3	ND	13.9	ND	0.1	0.4	0.4	0.2
Miscellaneous												
SS022285-141	2.9	6.6	2.4	ND	ND	ND	ND	ND	ND	ND	ND	ND
Poplar Creek												
SS020785-117	2.3	<1.0	<1.0	ND	ND	ND	1.8	ND	ND	2.6	2.7	2.4
SS020785-115	2.9	<1.0	5.0	ND	ND	2.1	ND	3.0	0.2	9.8	6.6	12.1
SS021185-154R	2.7	<1.0	<1.0	ND	0.4	ND	96.7	ND	0.1	0.5	0.7	0.8
SS021185-155R	2.4	<1.0	<1.0	ND	0.5	ND	1.2	ND	ND	1.1	1.0	1.6

ND = Not Detected

^aTOC = total organic carbon.

^bOrganic compound codes are as follows: 2B = Acenaphthylene;
 3B = Anthracene; 5B = Benzo(a)Anthracene; 13B = Bis(2-ethylhexyl)phthalate;
 18B = Chrysene; 26B = di-N-Butylphthalate; 31B = Fluoranthene;
 44B = Phenanthrene; 45B = Pyrene.

Table 11. Areas with radioisotope levels
exceeding 150% of K-25 mean

Area/sample No.	Radioisotopes (pCi/g) ^a				
	⁷ Be	¹³⁷ Cs	⁶⁰ Co	²³⁸ U	²³⁵ U
Clinch River					
SS013185-22	ND	14.90	0.70	ND	ND
SS013085-14	ND	13.40	1.07	ND	ND
SS013185-21	0.22	5.71	0.64	ND	ND
SS021185-151L	ND	12.82	1.14	ND	ND
SS013185-24	0.81	7.16	0.49	ND	ND
SS021585-166L	ND	9.15	0.70	2.8	0.1
SS021585-165L	ND	6.41	0.19	ND	ND
SS021585-164L	0.33	8.57	0.84	ND	ND
SS021585-163L	0.85	7.04	0.55	ND	ND
SS022185-208	ND	7.87	0.45	5.5	0.7
SS013185-30	0.63	11.20	0.85	5.0	0.2
SS022185-209	ND	12.28	0.77	ND	ND
SS021585-162L	0.69	7.22	0.71	ND	ND
SS021585-161R	ND	7.77	0.52	ND	ND
SS020785-129	1.52	14.40	1.34	ND	ND
SS020785-123	0.80	7.21	0.66	ND	ND
SS021185-156L	ND	8.75	0.61	ND	ND
SS021185-157L	ND	9.05	0.86	ND	ND
WB021485[0-4CM]	ND	9.70	0.80	ND	ND
Clinch River Trib 1					
SS012485-10	ND	3.73	ND	ND	ND
SS012485-11R	1.80	5.26	0.38	ND	ND
SS012485-12R	1.74	5.29	0.33	ND	ND
SS012485-9L	ND	5.06	0.39	ND	ND
SS013185-23	ND	6.23	0.51	ND	ND
East Fork Poplar Creek					
SS022185-210	ND	4.00	1.42	ND	ND
SS022285-139	ND	3.27	0.94	ND	ND
EF021585(0-4)	ND	4.20	1.60	7.2	0.4
K1515					
SS013085-13	ND	12.90	1.38	ND	ND
SS013085-16	ND	0.29	1.94	ND	ND
SS013085-17	ND	10.50	1.35	ND	ND
SS013185-18	ND	14.30	1.85	ND	ND
SS013185-19	ND	12.60	1.27	ND	ND
SS013185-20	1.42	11.60	1.67	ND	ND
K1700 Stream					
SS020485-33L	5.29	1.00	ND	58.5	3.7
SS011085-6L	2.30	1.14	ND	76.8	5.4
SS011085-5R	6.29	0.99	ND	145.0	12.8
SS020485-49	ND	0.88	ND	57.1	7.0
SS020485-48	6.20	0.85	ND	80.9	6.4
SS011085-4L	ND	1.39	0.20	254.0	19.5
SS011085-3L	1.61	1.24	0.8	82.4	7.1
SS011085-2L	1.83	1.06	ND	81.7	7.5
Poplar Creek					
SS020685-52R	ND	4.26	1.70	ND	ND
SS020685-67	2.05	1.38	1.28	ND	ND
SS020685-76	1.38	1.41	1.25	ND	ND
SS021185-154R	0.71	1.46	1.01	ND	ND
SS020885-94R	ND	3.30	0.35	6.8	0.7
SS021185-155R	4.20	3.49	0.72	ND	ND
Powerhouse					
SS013185-28	0.66	3.03	0.35	ND	ND
SS013185-29	1.91	3.45	0.17	12.8	1.2

ND = Not Detected

watershed for the K1700 stream, and its high silver and lead levels are consistent with similarly high levels in that stream.

The metal and organic levels shown for the Clinch River are interesting, but probably do not indicate any significant K-25 sources. Sample 165L was taken from the opposing bank of the river downstream of the Gallaher Road Bridge and upstream of the K710A powerhouse (Fig. 1 and Appendix A, p. A-11). This is a backwater area, and the reason for the relatively high selenium level is not apparent. The other sample is actually the top 4 cm of the core taken from the Clinch River near the city of Kingston. The cadmium value should be verified before the suspected source is investigated further. Sample 10 (Appendix A, p. A-12), which appears high in phthalate, is also in a backwater area below the K1515 water treatment plant. Again, the source is unclear.

The ^{137}Cs and ^{60}Co in the Clinch River are most likely from ORNL (Turner, Olsen, and Wilcox 1985). These radioisotopes are concentrated in the K1515 sludges. The radioisotope levels in Clinch River Tributary 1, which is downstream of K1515 (Fig. 1), indicate that this area is probably a backwater area, instead of a source to the Clinch River.

The metal, organic, and ^{238}U levels in K1007B pond (Fig. 1) may be attributable to lab drains which are reported to empty into this pond (J. E. Stone, personal interview, February 1985).

High levels of uranium isotopes, Ag, Cd, Cu, Ni, and Zn in the K1700 Stream (Fig. 1 and Appendix A, p. A-4) may be due to the metal cleaning and other operations in K1420. However, since these samples generally represent recent deposition, and since drains from K1420

currently go to one or more of the K1407-B holding ponds and since K 1407-C Pond once received sediment from K-1407-B Pond (Fig. 1), some connection must exist, or must have existed in the recent past, between the ponds and the surface stream sediments.

The actual mechanism for this connection is unclear. An electromagnetic conductivity survey of the K1407C pond (R. H. Ketelle, and T. L. Ashwood, unpublished data, March 1985) indicated the presence of a groundwater plume from the pond toward the stream; however, it is by no means certain that groundwater contamination is the only source of elevated sediment levels. The K1407B pond has an overflow discharge directly into the K1700 stream. Contamination has been detected both upstream and downstream from this discharge. Another possible contamination mechanism might be breaching and/or erosion of the pond embankments. For example, there appears to be a small seep in the K1407C embankment adjacent to sample 41R (Appendix A, p. A-4).

Samples 5R, 48, and 49, collected upstream of the K1700 weir (Appendix A, p. A-4), had a visible, oily sheen. Apparently the excessive hydrocarbon levels effectively blinded the PCB scan (L. W. McMahon, personal interview, May 1985). Further analyses should be conducted.

The sources of elevated arsenic and lead levels in the K1700 stream also are unclear. High TOC and miscellaneous organics might well come from the coal pile and/or K1420 activities.

East Fork Poplar Creek appears to be a source of Cd, Pb, Hg, ¹³⁷Cs, ⁶⁰Co, ²³⁸U and several organics. The Hg from East Fork Poplar Creek is evident in decreasing levels downstream in Poplar

Creek. The role of East Fork Poplar Creek as a contaminant source is discussed further in Sect. 3.2, Sediment Cores.

In addition to K1700 and East Fork there are two other areas along Poplar Creek that have high contaminant levels in the sediments. The stretch of stream that separates K31 and K27 (Fig. 1 and Appendix A, p. A-6) contains sediments having elevated levels of uranium isotopes and silver (sample points 84L, 86R, 88R, and 89R). Since the K27 area contains the purge cascade, which has an atmospheric vent, the elevated uranium levels could represent released material. However, a more likely explanation is that the uranium comes from the K1700 Stream. The silver anomaly is also consistent with K1700 sediments. It should also be noted that several anomalously high silver concentrations have been measured in the sediment core collected in the segment of Poplar Creek downstream of K27 (Appendix E).

Sediment from a pipe outfall downstream of the K27 facility (Appendix A, p. A-6, sample point 115) contains elevated levels of Cr, Zn, PCB, and various organics. PCBs do not show up in samples downstream of this point.

The K710A powerhouse area (Appendix A, p. A-10, samples 29, 204, and 207) appears to be a source of uranium contamination, although the Clinch River sediments below the powerhouse (Appendix A, p. A-9, samples 162L and 161R) do not show uranium contamination. Use of the powerhouse for storage of uranium-contaminated metal scrap from the Cascade Improvement Program may account for elevated uranium levels.

3.2 SEDIMENT CORES

Deposition, in association with particulate matter, is the principal mechanism for removing chemically reactive contaminants from aquatic systems (Olsen, Cutshall, and Larsen 1982), and burial by sedimentation is the principal mechanism for isolating these contaminants from contact with epibenthic and pelagic biota (Cutshall, Larsen, and Nichols 1981). Since the fine-grained sediments accumulating in river-reservoir areas generally reflect the character of the material transported or released into these areas, changes in the contaminant concentration or chemistry associated with this material generally reflect changes in contaminant input. This pollution input history is recorded in the sedimentary column and can be documented using sedimentary core data.

The concentration and vertical distribution of several radionuclides, organic compounds, and metals in the three cores collected as part of this study are illustrated in Fig. 2. The respective vertical distribution data are listed in Appendix E along with additional data for several other contaminants. It is evident from Fig. 2 and Appendix E that contaminant levels in subsurface sediments often greatly exceed concentrations near the surface, reflecting the relatively large quantities of contaminants released during the 1950s and early 1960s. Turner, Olsen, and Wilcox (1985) have shown the Hg and ^{137}Cs profiles in sediment cores collected from the Clinch River and Watts Bar Reservoir to be strongly correlated with documented discharge histories for Hg from the Y-12 Plant and ^{137}Cs from ORNL. With an independent means of determining an accurate

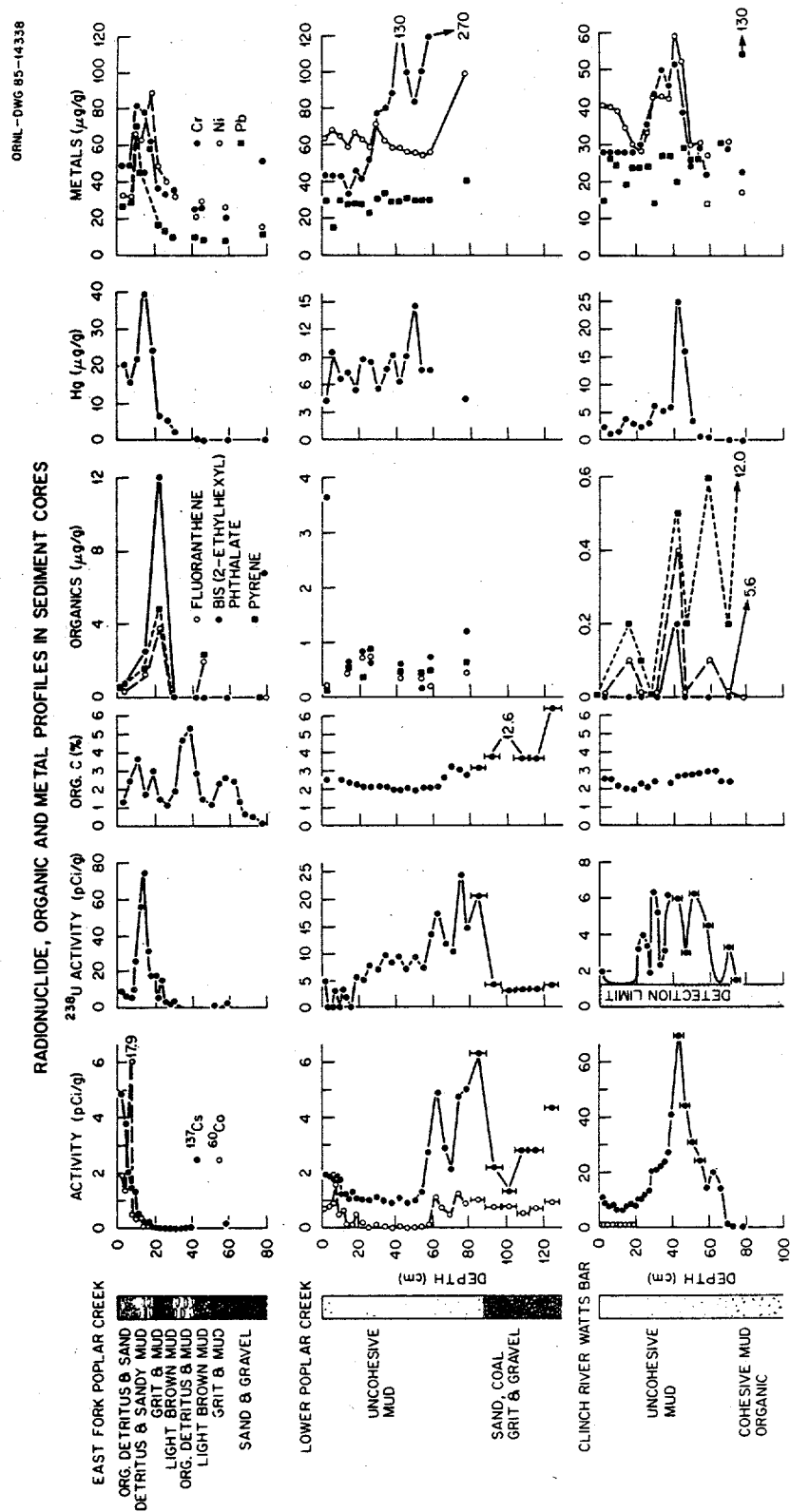


Fig. 2. Radionuclide, organic and metal profiles in sediment cores

sediment chronology (perhaps from other natural radionuclides or pollen profiles), it would be possible to estimate contaminant transport times and total contaminant retention within the Poplar Creek, Clinch River, and Watts Bar Reservoir systems, but such estimates would require several more core profiles, as well as data concerning contaminant water-to-particle distributions, an undertaking beyond the objectives of this study.

A comparison of the concentration and vertical distributions of ^{137}Cs and ^{60}Co in the East Fork Poplar Creek core with concentrations and distributions in the other two cores (Fig. 1 and Appendix E) indicates that the Y-12 Plant and the city of Oak Ridge have been relatively insignificant sources of these two radionuclides, relative to the input from ORNL via White Oak Creek and the Clinch River. The large subsurface peak of ^{60}Co in the East Fork Poplar Creek core at the 4- to 6-cm-depth interval, however, is an order of magnitude greater than the maximum level of ^{60}Co measured for the 180 surface sediment samples collected throughout the system (Table 8). This subsurface peak does not coincide with the deeper (12 to 16 cm) peak in Hg and ^{238}U concentration (Fig. 2) and, when compared with the ^{60}Co distributions in surface sediments along East Fork Poplar Creek, implies that there has been a relatively recent and large release of this radionuclide from the Oak Ridge Sewage Treatment Facility (Merritt 1984). Although ORNL is the source of most of the ^{60}Co in the Poplar Creek, Clinch River, and Watts Bar Reservoir system, it is apparent that this recent release from the Oak Ridge Sewage Treatment Plant has been manifested throughout the lower portion

of Poplar Creek, as evidenced by the ^{60}Co peak at the 6- to 8-cm-depth increment of the Lower Poplar Creek core (Fig. 2).

Although large variations in the sedimentary characteristics of the East Fork Poplar Creek core (Fig. 2) make it difficult to document the history of contaminant discharge accurately, the high concentrations of Hg and ^{238}U in this core, the coincidence of their subsurface peaks, and their general decrease in concentration downstream imply that releases from the Y-12 Plant may be a significant source of both contaminants. In addition, the relatively high concentrations of Pb, Cd, Cu, Zn, and several organic compounds in this core (Appendix E) imply that discharges from Y-12 may be an important source of these contaminants relative to releases from other facilities on the Oak Ridge Reservation.

The sediments in the top 88 cm of the Lower Poplar Creek core consisted of uncohesive, fine-grained muds, exhibiting little variation in sediment texture or organic carbon (Fig. 2). Below 88 cm, to the core bottom at 128 cm, the sediments consisted of relatively coarse-grained sands, coal, slag, ash, and gravel. Although ^{137}Cs , ^{60}Co , and ^{238}U concentrations sharply decreased below 88 cm, all three nuclides were nevertheless detectable to the core bottom, and organic carbon and ^{226}Ra concentrations actually increased by a factor of 2 to 3 in the coarse-grained material below (Appendix E). We interpret this abrupt change in sedimentary characteristics to reflect the 1964 cessation of discharge associated with the operation of the K710A powerhouse on the Clinch River (Fig. 1). This powerhouse operated from the mid 1940s to 1964 (T. C. Wilson, telephone

conversation, August 1985), pumping water from the Clinch River and discharging this water into Poplar Creek near the site of core collection (Fig. 1). Surface sediment samples (26 and 27, see Appendix A, p. A-10) collected along this discharge route (which is now a backwater area of Poplar Creek) were contaminated with ^{137}Cs (Appendix B) as a result of this pumping-discharge operation. We suggest that the coarse-grained material reflects the erosion of fine-grained material and the deposition of sand, coal, slag, and ash during discharge from the powerhouse. In addition, we suggest that the top 88 cm of fine-grained sediment reflects the accumulation of backwater muds since 1964. The high concentrations of ^{137}Cs and ^{60}Co and the relatively low concentration of Hg in the sediments between 88 and 60 cm imply that Clinch River muds formed a major component of the fine-grained material which accumulated immediately after powerhouse operation ceased in 1964. Since the major releases of both Hg and ^{238}U from the Y-12 Plant occurred prior to 1964 (Turner, Olsen, and Wilcox 1985), we suggest that the sharp increase in ^{238}U concentration at 88 cm does not reflect a large release of uranium but reflects the change in sedimentary character. We also suggest that the gradual decrease in ^{238}U concentrations from 88 cm to the sediment surface reflects a general decrease in the extent of ^{238}U contamination since 1964. In addition, the high concentrations of Ni, Ag, Cr, and Zn in the Lower Poplar Creek core relative to the other cores (Appendix E) are consistent with the surface sediment data, which indicate that the primary source of these metals is discharges from the K-25 facility. Two major uncertainties which may affect the preceding

evaluation are the unknown effects of closing Melton Hill Dam (ca. 1963) and the two-way circulation patterns in Poplar Creek caused by seasonal water level fluctuations. Further study of these phenomena is required before our evaluation can be confirmed.

The Watts Bar Reservoir core was collected from an area where the Clinch River widens into Watts Bar Lake. Because Watts Bar Dam was first closed in 1942 and because reservoirs serve as efficient fine-particle and contaminant traps, this core should contain a complete pollution record, integrating discharges from all three of the DOE facilities on the Oak Ridge Reservation. Although the ^{238}U concentrations in the sediments of this core (Appendix E) are very near our detection limit for a 1000-min count and 80 gram sample (1.4 pCi/g), there appear to be several peaks in the ^{238}U concentration below 20 cm (Fig. 2). This is not consistent with data published previously by Turner, Olsen, and Wilcox (1985) which indicated that there was only one peak in the ^{238}U concentration and that this peak correlated with the peak levels of Hg and ^{137}Cs . At the present time, it is still not possible to discern the relative contribution of ^{238}U from the K-25 facility. The strong correlation between the Hg and ^{238}U profile in the East Fork Poplar Creek core implies that the Y-12 facility maybe a significant source for the uranium contamination in the Poplar Creek, Clinch River and Watts Bar Reservoir system, but an examination of Hg and U peak and inventory ratios in several more cores collected downstream of the East Fork Poplar Creek site would be needed to document this with more certainty. In addition, a comparison of the ^{238}U peak profile in the

Watts Bar core with an accurate sediment chronology and ^{238}U release records from the K-25 plant would help discern the extent and history of uranium contribution from the K-25 facility.

4. SUMMARY AND CONCLUSIONS

Based on approximately 180 sediment grab samples and 3 sediment cores, the following areas appear to have levels of various contaminants which exceed the K-25 mean levels:

- K901A Chromate Pond--Cr, Se, Zn, and some organics;
- Classified Burial Ground--Ag, Pb, and Se;
- Clinch River--Cd, Se, ^{137}Cs , ^{60}Co , and ^{238}U ;
- K1007B Pond--Ag, Cd, Cr, PCB, and ^{238}U ;
- K1700 Stream--Ag, As, Cd, Cr, Ni, Pb, Se, Zn, several organics, and uranium isotopes;
- East Fork Poplar Creek--Cd, Hg, Pb, Se, several organics, ^{137}Cs , ^{60}Co and ^{238}U ;
- Poplar Creek--Ag, Cd, Cr, Hg, Se, Zn, several organics, PCB, and radioisotopes;
- K710A Powerhouse--Uranium isotopes

Several conclusions can be drawn from a review of these data, including:

1. ^{137}Cs and ^{60}Co come primarily from ORNL via the White Oak Creek and the Clinch River; however, some ^{137}Cs and ^{60}Co have recently entered Poplar Creek via East Fork;
2. Although surface sediments in several areas (primarily K1700, K710A, and K27) are contaminated with uranium, the significance of these areas as sources of uranium contamination in the major streams is uncertain;
3. Mercury contamination is coming from East Fork Poplar Creek;
4. The most heavily contaminated sediments occur in the K1700 stream and the K901A chromate pond. The actual effects of these potential sources on Poplar Creek and the Clinch River are not clear.
5. PCB contamination from K1007B and the pipe outfall at K1203 do not appear to be manifested at levels greater than $1\text{ }\mu\text{g/g}$ in sediments downstream from these sites.

5. ACKNOWLEDGMENTS

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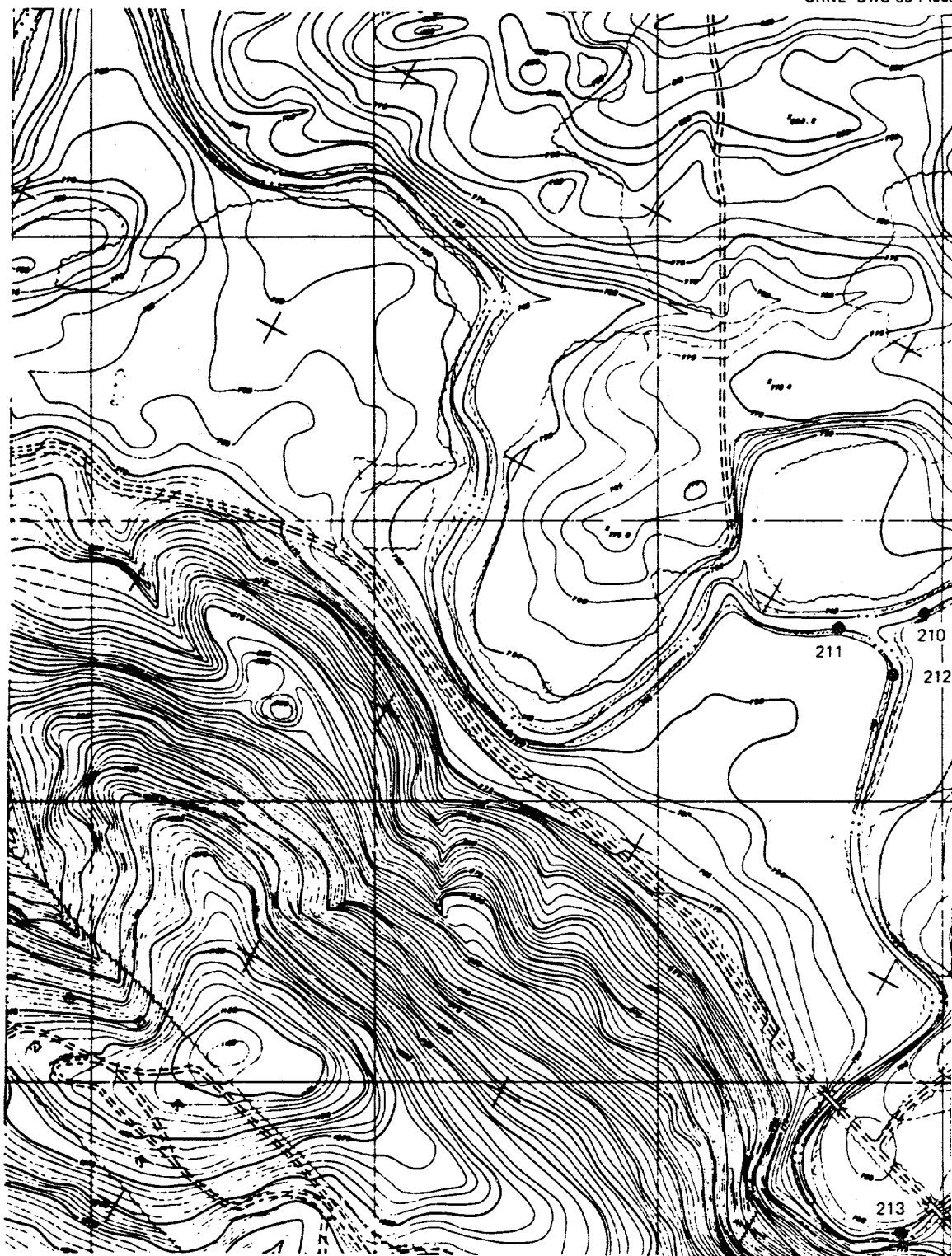
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APPENDICES

APPENDIX A
SAMPLE LOCATIONS



East Fork Poplar Creek and Bear Creek

ORNL-DWG 85-14340

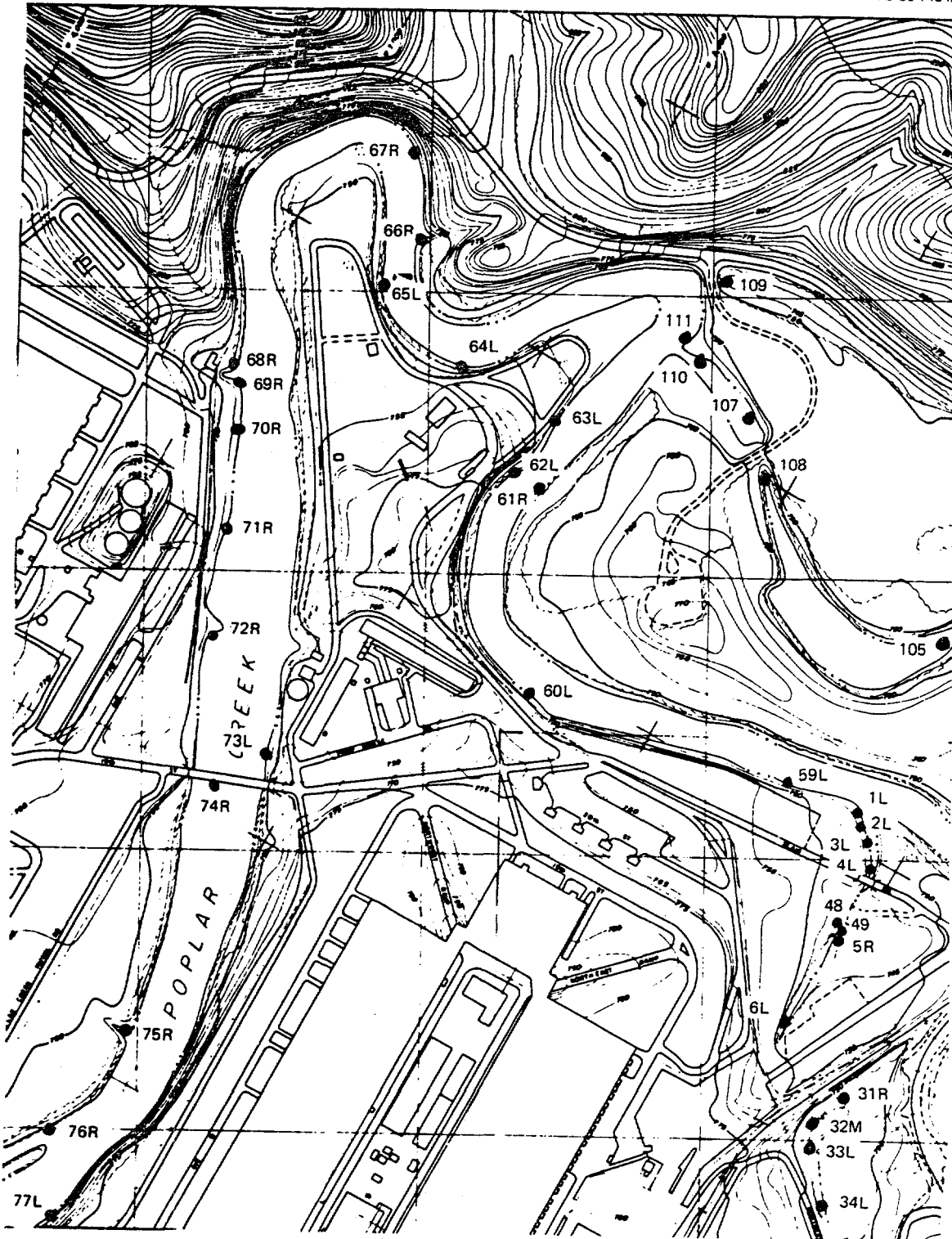


Upper Poplar Creek and East Fork

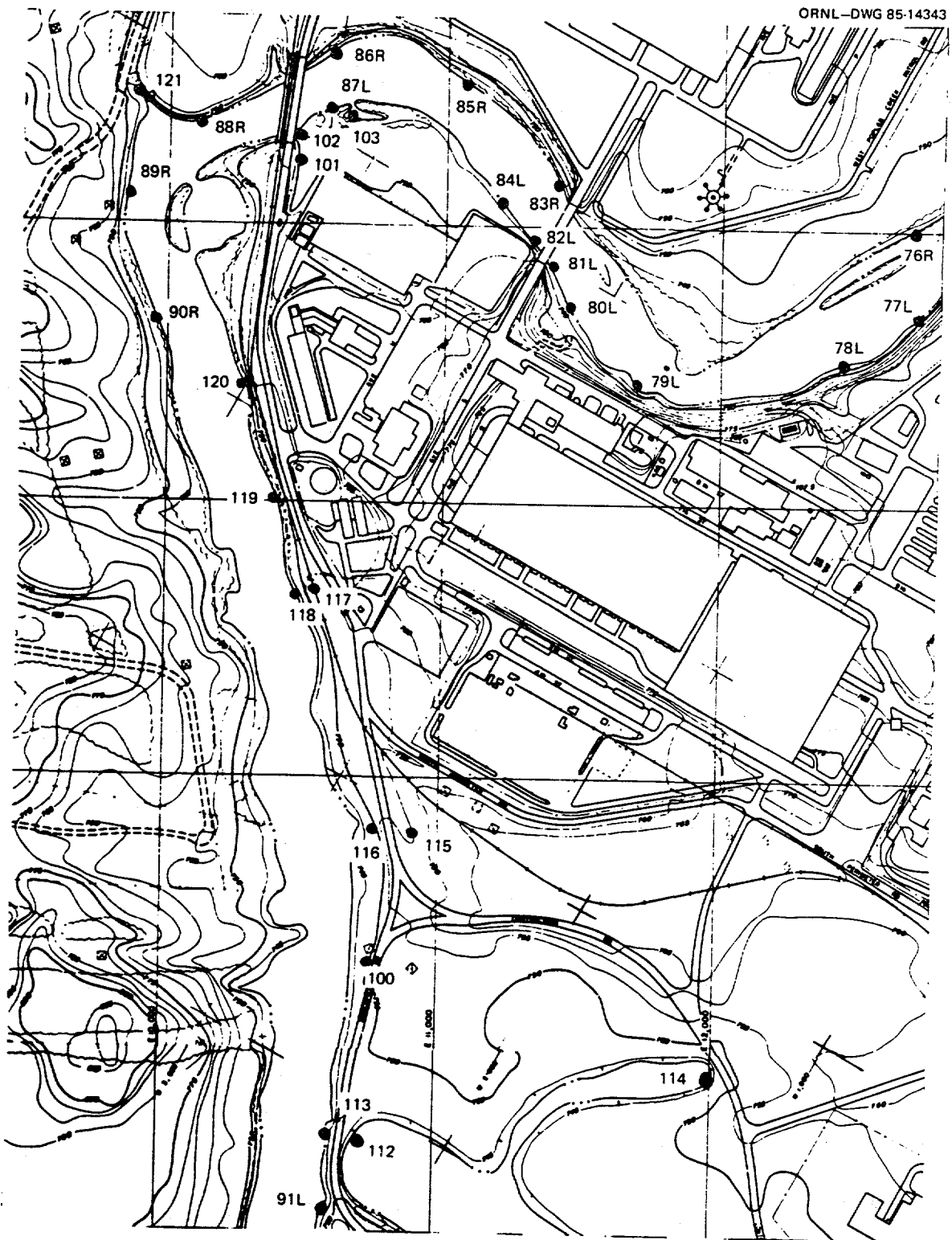


K1700 Stream

ORNL-DWG 85-14342

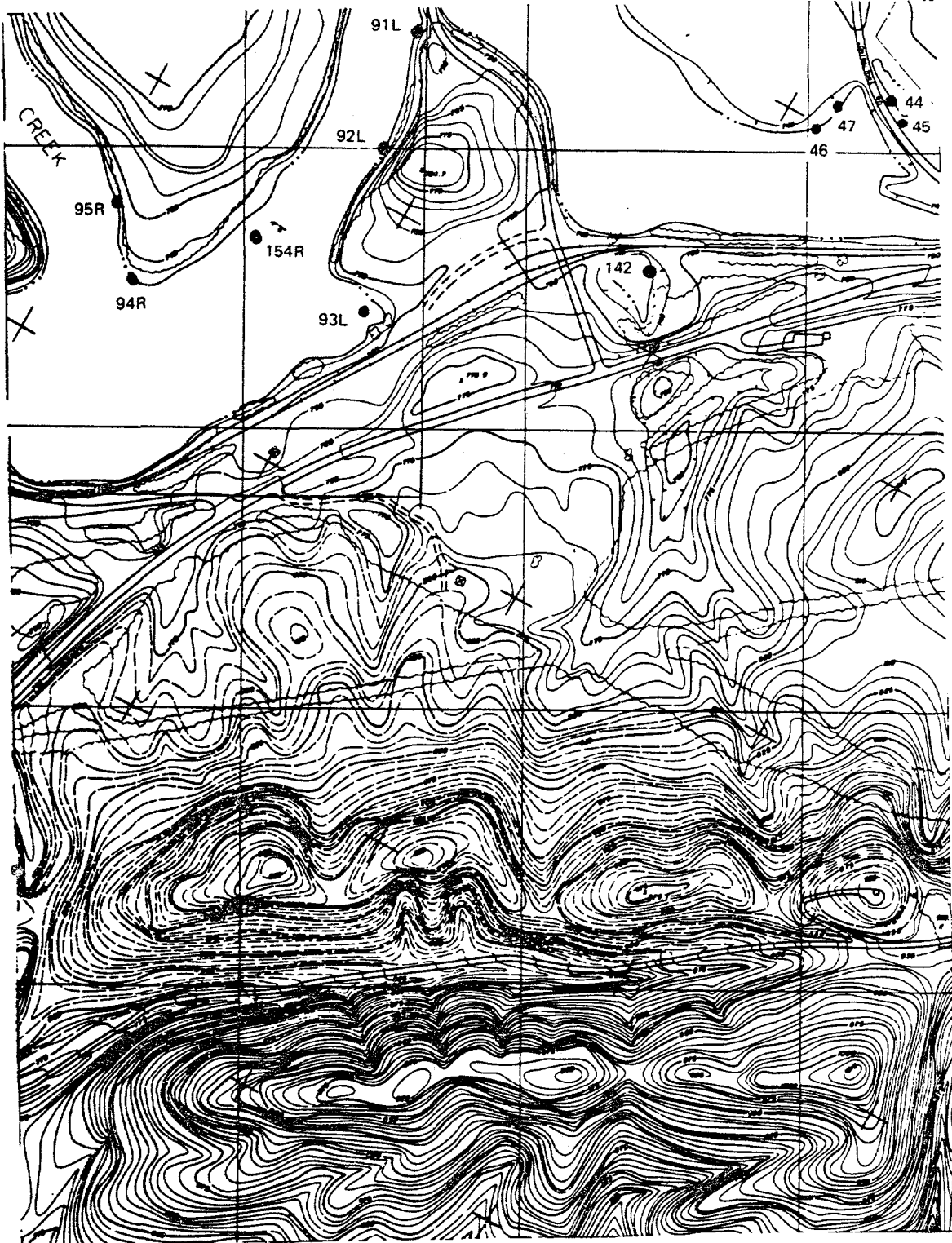


Poplar Creek

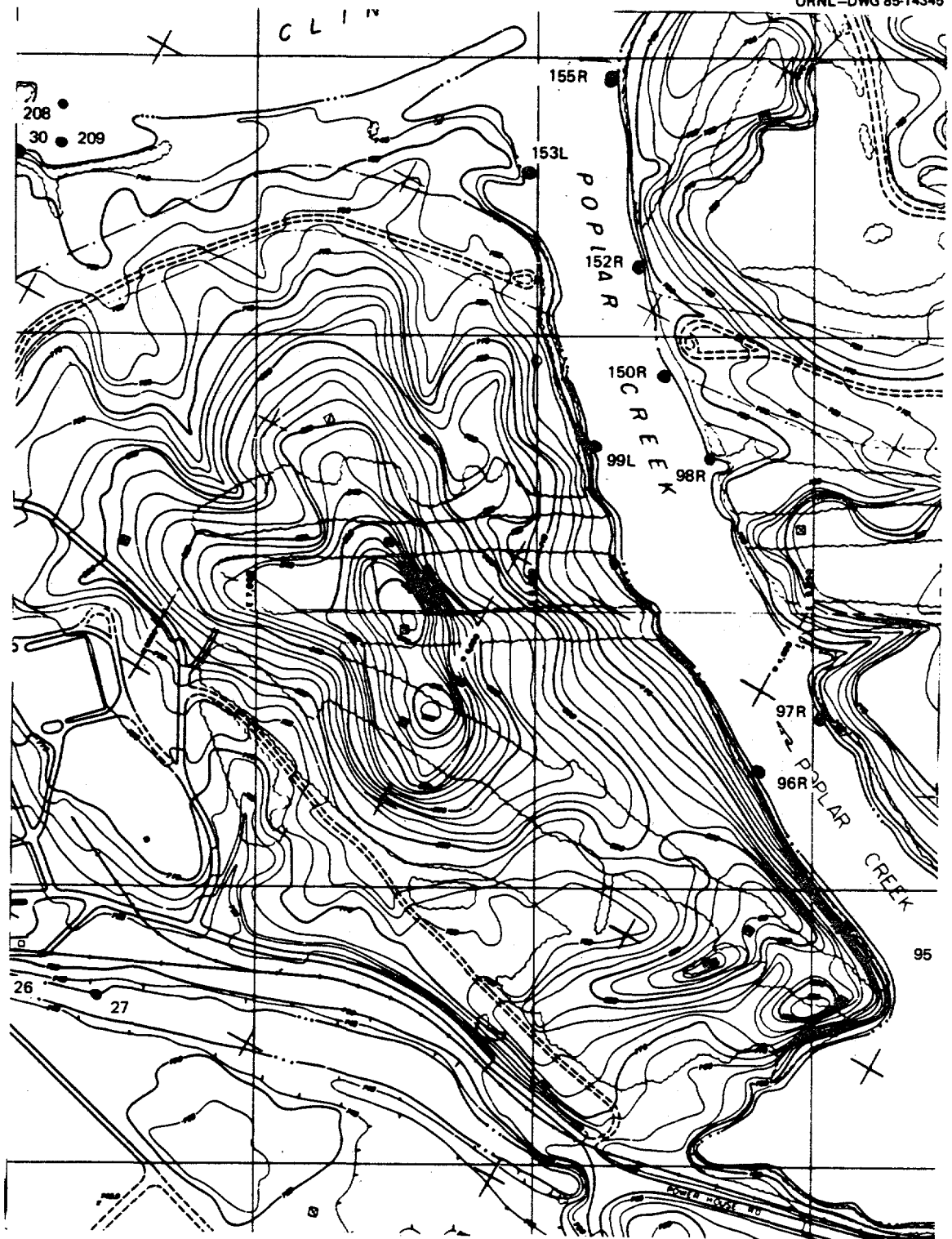


Poplar Creek

ORNL-DWG 85-14344

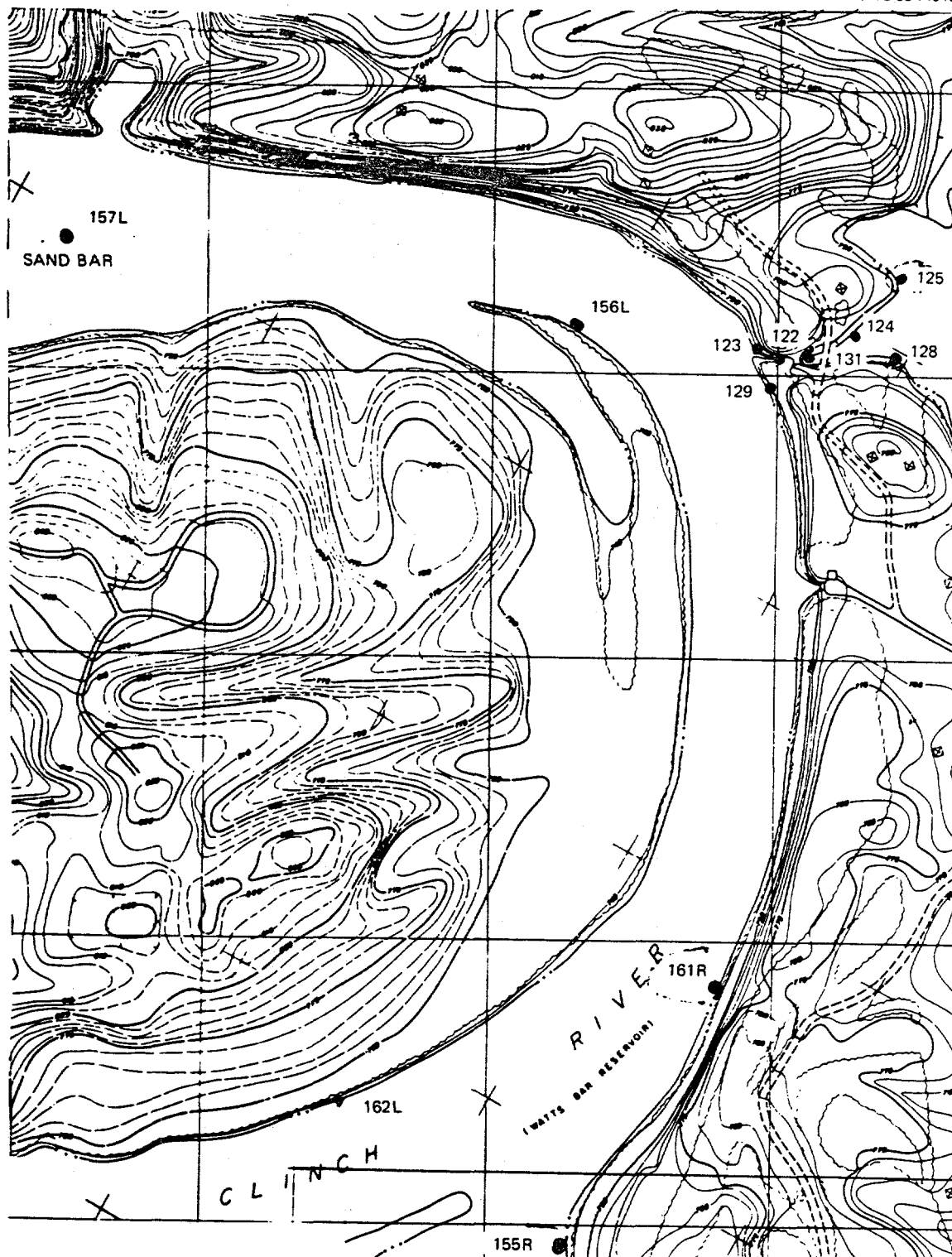


Poplar Creek and K1007B

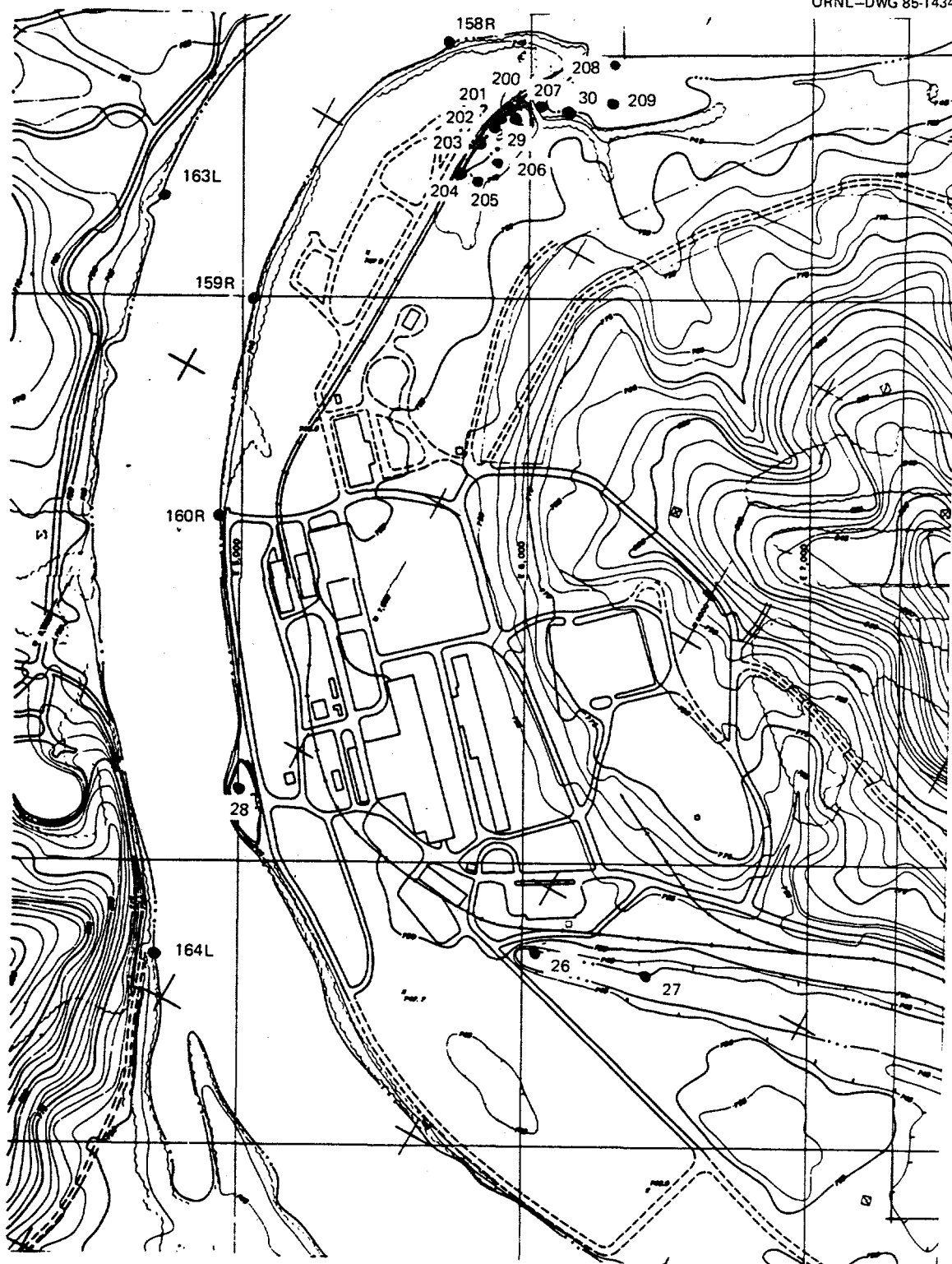


Poplar Creek

ORNL-DWG 85-14346

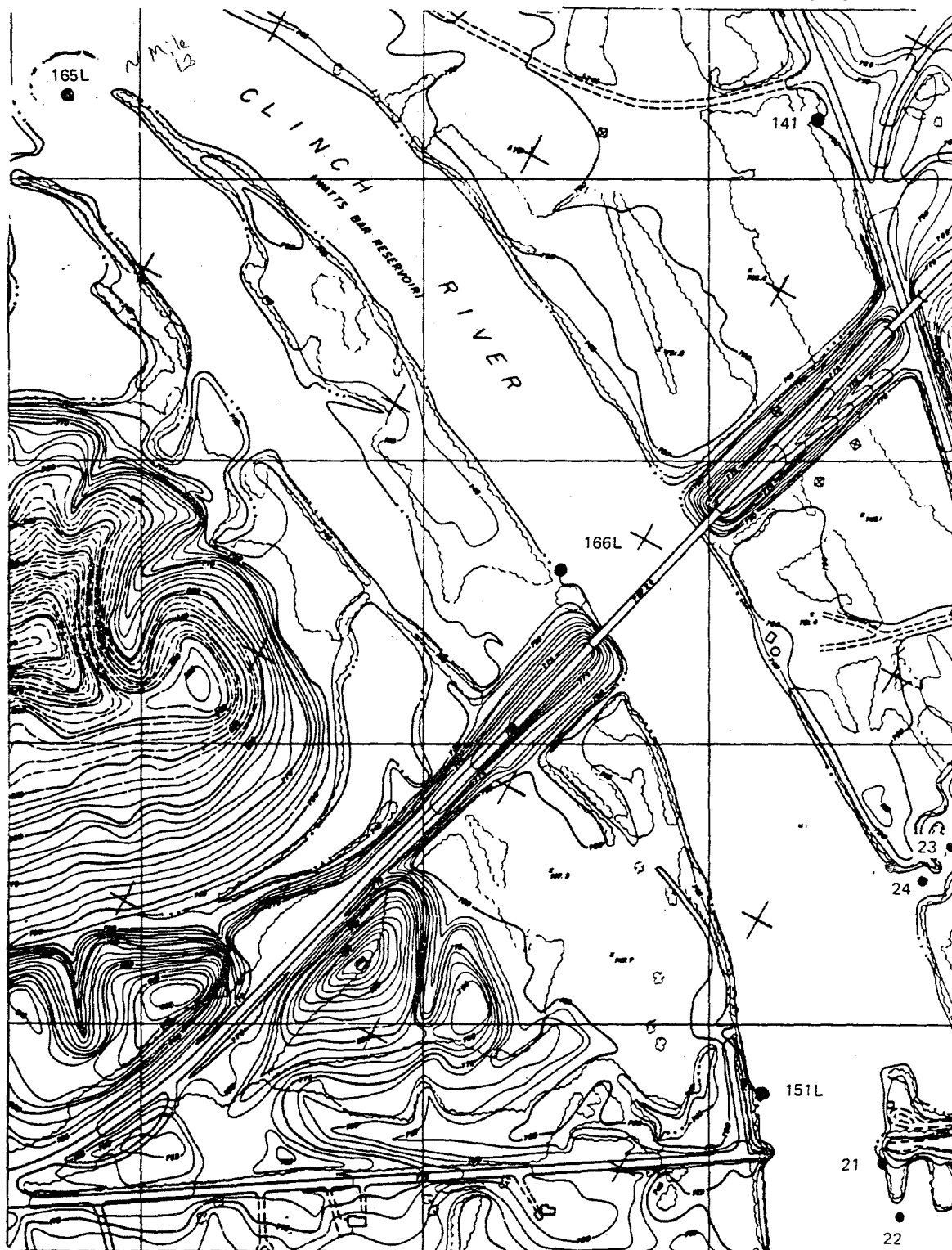


Clinch River

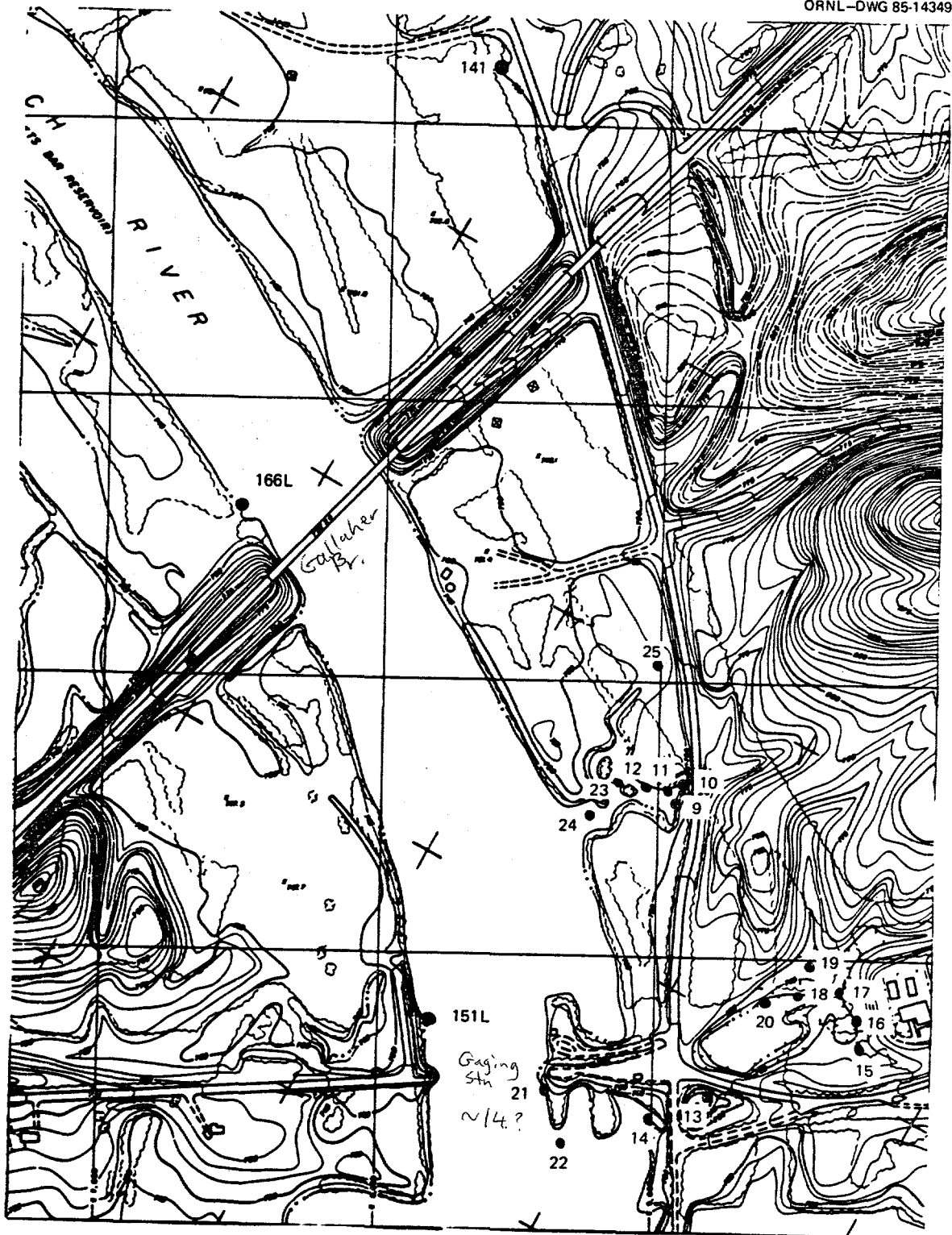


Clinch River and K710A Powerhouse

ORNL-DWG 85-14348

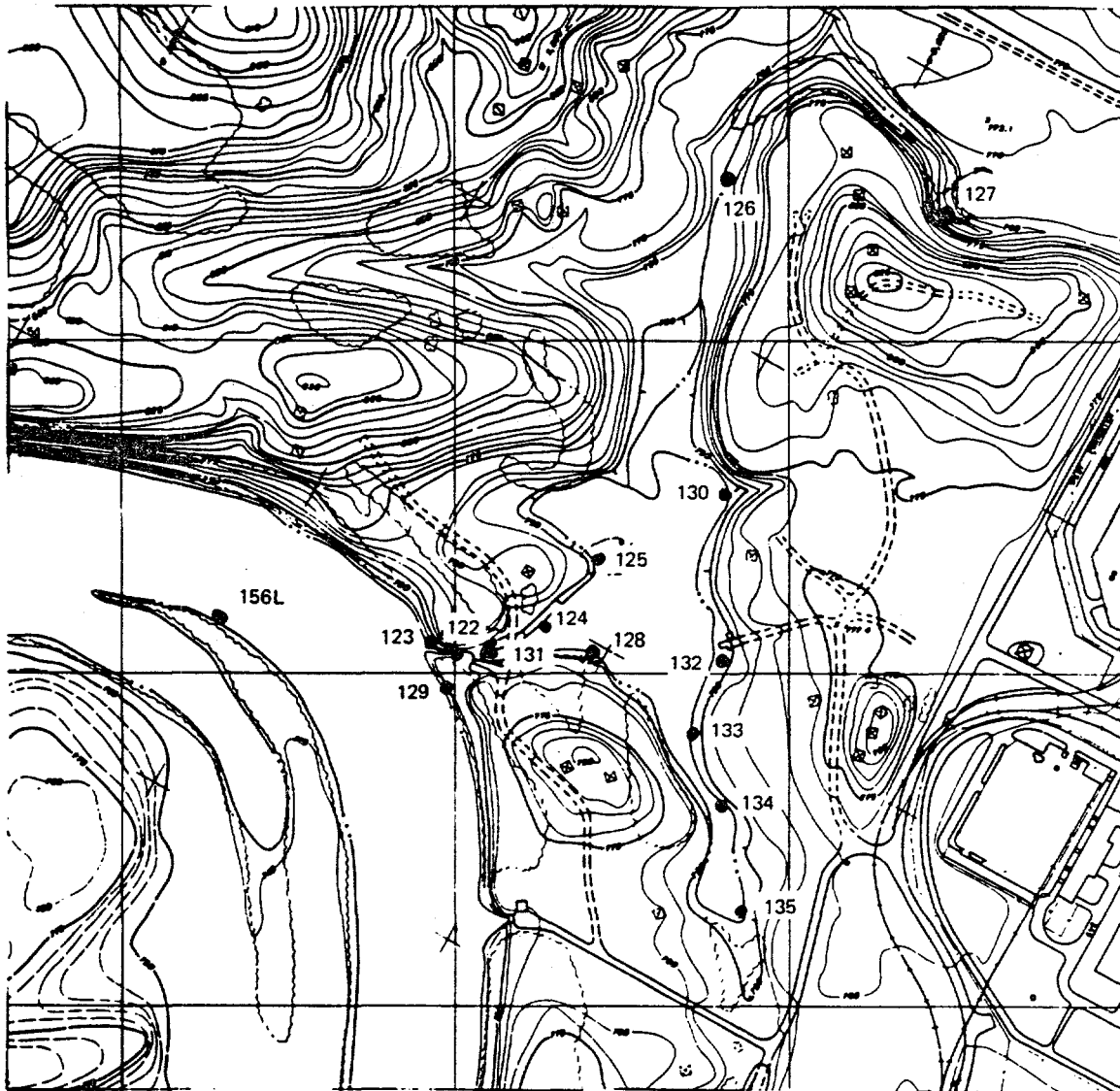


Clinch River



Clinch River and K1515

ORNL-DWG 85-14350



K-901A Chromats Pond



Miscellaneous

APPENDIX B
RADIOISOTOPES

APPENDIX B
RADIOISOTOPE DATA

AREA/SAMPLE NO.	RADIOISOTOPES (pCi/g)				
	Be7	Cs137	Co60	U238	U235
CHROMATE POND					
SS020785-122	1.78	1.74	.20	2.7	ND
SS020785-124	1.00	.49	ND	ND	ND
SS020785-125	2.65	1.13	.15	4.7	ND
SS020785-126	ND	1.09	.17	ND	ND
SS020785-127	ND	1.21	.15	ND	ND
SS020785-128	ND	.06	ND	2.6	ND
SS020785-130	.98	1.33	.19	ND	ND
SS020785-131	2.96	.69	ND	ND	ND
SS020885-132	.57	.40	ND	ND	ND
SS020885-133	1.46	1.94	.19	ND	ND
SS020885-134	ND	.63	ND	3.8	ND
SS020885-135	3.04	1.41	ND	ND	ND
CLASS. BURIAL GRND					
SS020485-42	.17	.16	ND	1.9	ND
SS020485-43	.56	.15	ND	2.9	ND
SS022885-215	ND	.34	ND	ND	ND
SS022885-216	ND	.32	ND	ND	ND
SS022885-217	ND	ND	ND	ND	ND
SS022885-218	.77	.14	ND	ND	ND
CLINCH RIVER					
SS013185-22	ND	14.90	.70	ND	ND
SS013085-14	ND	13.40	1.07	ND	ND
SS013185-21	.22	5.71	.64	ND	ND
SS021185-151L	ND	12.82	1.14	ND	ND
SS013185-24	.81	7.16	.49	ND	ND
SS021585-166L	ND	9.15	.70	2.8	.1
SS021585-165L	ND	6.41	.19	ND	ND
SS021585-164L	.33	8.57	.84	ND	ND
SS021485-160R	ND	1.41	.12	ND	ND
SS021485-159	.26	2.38	.24	ND	ND
SS021585-163L	.85	7.04	.55	ND	ND
SS021485-158R	.80	.31	ND	ND	ND
SS022185-208	ND	7.87	.45	5.5	.7
SS013185-30	.63	11.20	.85	5.0	.2
SS022185-209	ND	12.28	.77	ND	ND
SS021585-162L	.69	7.22	.71	ND	ND
SS021585-161R	ND	7.77	.52	ND	ND
SS020785-129	1.52	14.40	1.34	ND	ND
SS020785-123	.80	7.21	.66	ND	ND
SS021185-156L	ND	8.75	.61	ND	ND
SS021185-157L	ND	9.05	.86	ND	ND
WB021485[0-4CM]	ND	9.70	.80	ND	ND

RADIOISOTOPE DATA

AREA/SAMPLE NO.	RADIOISOTOPES (pCi/g)				
	Be7	Cs137	Co60	U238	U235
CLINCH RIVER TRIB 1					
SS012485-10	ND	3.73	ND	ND	ND
SS012485-11R	1.80	5.26	.38	ND	ND
SS012485-12R	1.74	5.29	.33	ND	ND
SS012485-9L	ND	5.06	.39	ND	ND
SS013185-23	ND	6.23	.51	ND	ND
SS013185-25	ND	2.25	.20	ND	ND
EAST FORK POPLAR CR					
SS022185-210	ND	4.00	1.42	ND	ND
SS022185-211	ND	.15	ND	ND	ND
SS022185-212	ND	.08	ND	ND	ND
SS022185-213	ND	.19	ND	ND	ND
SS022285-138	4.85	1.53	ND	ND	ND
SS022285-139	ND	3.27	.94	ND	ND
SS022285-140	1.23	2.57	.96	3.3	ND
EF021585(0-4)	ND	4.20	1.60	7.2	.4
K1007B					
SS022285-142	ND	1.00	ND	ND	ND
K1007B (PC TRIB 4)					
SS020485-44	ND	.36	ND	ND	ND
SS020485-45	ND	.27	ND	ND	ND
SS020485-46	1.10	.43	.12	ND	ND
SS020485-47	ND	.31	ND	10.6	ND
SS020685-114	ND	.26	ND	ND	ND
K1515					
SS013085-13	ND	12.90	1.38	ND	ND
SS013085-15	ND	.68	ND	ND	ND
SS013085-16	ND	.29	1.94	ND	ND
SS013085-17	ND	10.50	1.35	ND	ND
SS013185-18	ND	14.30	1.85	ND	ND
SS013185-19	ND	12.60	1.27	ND	ND
SS013185-20	1.42	11.60	1.67	ND	ND
K1700 STREAM					
SS011085-8R	.36	.13	ND	ND	ND
SS011085-7R	.90	.10	ND	ND	ND
SS020485-41R	ND	.37	ND	8.7	.5
SS020485-39L	ND	.36	ND	ND	ND
SS020485-38R	.60	.47	ND	2.8	ND
SS020485-37R	.38	.48	ND	5.2	.6
SS020485-36R	1.42	.36	ND	14.4	.9
SS020485-35L	1.17	.63	ND	30.2	2.1
SS020485-34L	.51	.83	ND	15.0	1.1
SS020485-33L	5.29	1.00	ND	58.5	3.7
SS020485-32M	1.54	.89	ND	42.6	3.5

RADIOISOTOPE DATA

AREA/SAMPLE NO.	RADIOISOTOPES (pCi/g)				
	Be7	Cs137	Co60	U238	U235
K1700 STREAM					
SS020485-31R	2.16	.76	ND	4.4	2.8
SS011085-6L	2.30	1.14	ND	76.8	5.4
SS011085-5R	6.29	.99	ND	145.0	12.8
SS020485-49	ND	.88	ND	57.1	7.0
SS020485-48	6.20	.85	ND	80.9	6.4
SS011085-4L	ND	1.39	.20	254.0	19.5
SS011085-3L	1.61	1.24	.08	82.4	7.1
SS011085-2L	1.83	1.06	ND	81.7	7.5
SS011085-1L	.51	1.16	.36	29.4	2.5
MISCELLANEOUS					
SS020885-136	ND	.13	ND	3.1	ND
SS020885-137	ND	ND	ND	ND	ND
SS022185-214	ND	.91	ND	ND	ND
SS022285-141	ND	.25	ND	ND	ND
PC TRIB 3					
SS020685-105	.91	.53	ND	ND	ND
SS020685-106	1.69	.54	ND	ND	ND
SS020685-107	ND	.67	ND	ND	ND
SS020685-108	.64	.27	ND	ND	ND
SS020685-110	ND	1.02	.18	ND	ND
POPLAR CREEK					
SS021585-137	.60	.16	ND	ND	ND
SS021585-138R	ND	ND	ND	ND	ND
SS020685-50L	1.30	.40	ND	ND	ND
SS020685-51R	1.20	.20	ND	ND	ND
SS020685-52R	ND	4.26	1.70	ND	ND
SS020685-53R	1.52	.43	ND	ND	ND
SS020685-54R	1.92	.27	ND	ND	ND
SS020685-55R	ND	1.03	.23	ND	ND
SS020685-104	1.49	1.05	.41	ND	ND
SS020685-56R	2.38	1.09	.48	ND	ND
SS020685-57	.81	.99	.31	ND	ND
SS020685-58	1.98	1.23	.40	ND	ND
SS020685-59	1.49	1.06	ND	ND	ND
SS020685-60	2.33	.91	.17	ND	ND
SS020685-61	2.40	1.50	.57	ND	ND
SS020685-62	1.91	1.09	.37	ND	ND
SS020685-63	2.07	.95	.34	ND	ND
SS020685-111R	1.94	1.84	.56	ND	ND
SS020685-109	ND	1.06	.38	ND	ND
SS020685-64	ND	1.67	.47	ND	ND
SS020685-65L	1.70	1.26	.58	ND	ND
SS020685-66	ND	1.38	.65	ND	ND
SS020685-67	2.05	1.38	1.28	ND	ND
SS020685-68	1.45	1.61	.43	ND	ND

RADIOISOTOPE DATA

AREA/SAMPLE NO.	RADIOISOTOPES (pCi/g)				
	Be7	Cs137	Co60	U238	U235
POPLAR CREEK					
SS020685-69	1.57	1.46	ND	ND	ND
SS020685-70	1.45	1.22	.37	ND	ND
SS020685-71	.94	2.01	.50	ND	ND
SS020685-72R	1.86	1.94	.58	ND	ND
SS020685-73	1.21	1.27	.46	ND	ND
SS020685-74	2.11	1.39	.48	ND	ND
SS020685-75	.99	1.15	.32	ND	ND
SS020685-76	1.38	1.41	1.25	ND	ND
SS020685-77	3.01	1.28	.54	ND	ND
SS020685-78	2.72	1.39	.50	ND	ND
SS020785-79L	1.88	1.39	.96	ND	ND
SS020785-80L	1.10	1.86	.80	ND	ND
SS020785-81L	1.36	1.20	.62	ND	ND
SS020785-82L	ND	1.20	.64	ND	ND
SS020785-83R	2.87	1.41	.63	ND	ND
SS020785-84L	ND	1.76	.44	28.3	ND
SS020785-85R	ND	1.47	.39	ND	ND
SS020785-86R	2.67	1.39	.63	ND	ND
SS020685-103	ND	.45	ND	ND	ND
SS020785-87L	ND	1.42	.48	ND	ND
SS020685-102	1.69	1.15	.33	ND	ND
SS020685-101	.58	.45	ND	ND	ND
SS020785-88R	3.15	1.71	.56	24.2	ND
SS020785-121	.68	.72	.19	ND	ND
SS020785-89R	2.74	1.49	.42	13.5	ND
SS020785-90R	2.05	1.62	.70	ND	ND
SS020785-120L	.35	1.12	.17	6.3	.4
SS020785-119	1.90	.73	.64	6.5	ND
SS020785-117	.71	.93	.51	ND	ND
SS020785-118	.81	.96	.35	ND	ND
SS020785-115	1.02	1.29	.09	ND	ND
SS020785-116	ND	1.19	.18	ND	ND
SS020685-100L	ND	.72	ND	ND	ND
SS020685-112	ND	.15	ND	ND	ND
SS020685-113L	1.94	1.75	.60	ND	ND
SS020885-91L	1.28	1.41	.25	ND	ND
SS020885-92L	1.42	1.50	.58	5.8	ND
SS021185-154R	.71	1.46	1.01	ND	ND
SS020885-93L	ND	.93	.19	ND	ND
PC022085[0-4CM]	ND	ND	ND	ND	ND
SS020885-94R	ND	3.30	.35	6.8	.7
SS021185-95R	1.16	1.66	.83	ND	ND
SS020885-96L	ND	2.89	.45	ND	ND
SS020885-97R	ND	1.92	.61	ND	ND
SS020885-98R	2.01	2.52	.99	ND	ND
SS020885-99L	1.54	2.60	.68	ND	ND
SS020885-150R	ND	2.49	.62	ND	ND
SS021185-152R	ND	2.47	.41	ND	ND

RADIOISOTOPE DATA

AREA/SAMPLE NO.	RADIOISOTOPES (pCi/g)				
	Be7	Cs137	Co60	U238	U235
POPLAR CREEK					
SS021185-153L	1.00	2.52	.82	ND	ND
SS021185-155R	4.20	3.49	.72	ND	ND
POWERHOUSE					
SS013185-26	.22	.13	ND	ND	ND
SS013185-27	.34	.28	ND	ND	ND
SS013185-28	.66	3.03	.35	ND	ND
SS013185-29	1.91	3.45	.17	12.8	1.2
SS022185-200	.50	1.07	ND	ND	ND
SS022185-201	1.56	1.54	ND	ND	ND
SS022185-202	1.45	1.74	ND	ND	ND
SS022185-203	1.08	1.31	ND	ND	ND
SS022185-204	ND	.71	ND	24.5	2.1
SS022185-205	ND	1.30	ND	ND	ND
SS022185-206	ND	.74	ND	ND	ND
SS022185-207	.32	1.84	.13	19.5	.9

ND = Not Detected

APPENDIX C
ICP AND MERCURY DATA

APPENDIX C

RESULTS OF METALS ANALYSES

AREA/SAMPLE No.	METALS (ug/g)									
	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
CHROMATE POND										
SS020785-124	<.6	<5	<.3	740	9	.3	27	17	120	230
SS020785-125	<.6	<5	<.3	2800	28	<.2	10	8	<5	990
SS020785-126	1.2	<5	<.3	1600	8	.6	5	8	<5	410
SS020785-127	<.6	<5	<.3	250	0	1.1	2	5	<5	350
SS020785-130	1.5	<5	<.3	3300	8	.6	6	5	<5	900
SS020885-132	1.8	<5	<.3	410	5	<.1	20	14	110	140
SS020885-133	<.6	<5	<.3	2100	17	.9	26	16	88	560
SS020885-135	<.6	9	<.3	1600	26	.8	39	24	110	230
CLASS. BURIAL GRND										
SS020485-42	23.0	<5	<.3	66	77	1.4	83	77	58	230
SS022885-216	1.2	<5	<.3	17	40	.9	120	10	140	41
CLINCH RIVER										
SS013185-21	<.6	<5	<.3	16	12	.7	12	9	39	35
SS021585-165L	1.3	<5	<.3	17	17	.8	24	12	110	92
SS021585-161R	3.7	<5	<.3	1	1	5.3	2	5	<5	6
WB021485[0-4CM]	1.4	7	1.8	44	38	4.2	64	30	<5	160
CLINCH RIVER TRIB 1										
SS012485-10	<.6	<5	<.3	51	4	.7	38	22	140	190
EAST FORK POPLAR CR										
SS022185-212	<.6	<5	.7	21	11	3.5	25	16	29	42
SS022285-138	<.6	<5	3.3	45	76	45.0	54	110	37	320
EF021585(0-4)	4.9	<5	<.3	49	40	20.7	33	26	110	130
K1007B (PC TRIB 4)										
SS020485-45	12.0	<5	<.3	150	56	<.5	89	47	38	210
SS020485-46	17.0	<5	1.0	63	63	<.5	86	37	21	220
K1700 STREAM										
SS020485-41R	<.6	23	<.3	39	250	<1.0	420	46	<5	160
SS020485-35L	<.6	<5	<.3	69	210	1.5	400	39	110	210
SS020485-34L	<.6	15	<.3	50	220	3.0	430	49	48	190
SS020485-33L	<.6	34	1.3	62	230	1.8	460	48	<5	240
SS020485-32M	89.0	45	1.1	65	250	2.9	520	73	<5	220
SS020485-31R	<.6	16	1.1	57	210	1.8	560	51	<5	240
SS011085-6L	1.8	22	.8	130	300	6.6	830	140	57	410
SS011085-5R	2.5	190	<.3	100	470	4.4	1200	100	280	450
SS020485-49	1.4	33	<.3	91	250	2.1	1000	97	150	330
SS011085-4L	<.6	170	4.6	98	440	4.6	950	120	<5	510
SS011085-3L	<.6	68	2.4	91	260	6.1	1300	94	<5	350

METALS ($\mu\text{g/g}$)

AREA/SAMPLE No.	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
K1700 STREAM										
SS011085-2L	1.4	45	2.2	88	260	6.1	1200	94	<5	370
SS011085-1L	<.6	15	1.5	57	140	9.5	420	49	<5	220
PC TRIB 3										
SS020685-105	<.6	<5	<.3	29	18	<.5	34	29	49	45
POPLAR CREEK										
SS021585-138R	8.8	<5	<.3	20	20	<.1	40	5	120	100
SS020685-52R	6.2	<5	2.0	67	78	25.6	44	43	72	200
SS020685-56R	<.6	<5	<.3	22	24	6.1	40	24	62	150
SS020685-61	1.4	<5	<.3	23	27	5.8	43	27	61	160
SS020685-111R	<.6	<5	<.3	56	47	11.0	59	30	77	170
SS020685-65L	2.6	<5	<.3	51	46	5.5	58	28	83	180
SS020685-72R	2.7	<5	<.3	60	48	8.3	62	41	110	200
SS020785-79L	1.8	<5	<.3	54	48	.0	59	30	89	180
SS020785-86R	44.0	<5	<.3	32	30	5.4	46	29	67	170
SS020785-120L	1.3	<5	<.3	95	35	9.5	51	27	60	210
SS020785-117	2.1	<5	<.3	87	42	5.4	57	40	83	230
SS020785-115	<.6	<5	<.3	610	62	<.5	68	48	45	590
SS020685-113L	<.6	<5	<.3	59	41	8.4	65	32	93	200
SS021185-154R	1.9	<5	<.3	33	37	4.8	56	10	130	140
PC022085[0-4CM]	1.4	<5	<.3	27	43	3.1	42	15	130	120
SS021185-155R	2.6	<5	<.3	46	41	7.7	60	20	160	150
POWERHOUSE										
SS013185-29	<.6	<5	<.3	45	38	3.0	51	58	76	190
SS022185-207	2.8	<5	<.3	31	54	2.0	48	42	110	180

APPENDIX D

ORGANICS

APPENDIX D

RESULTS OF GC-MS ANALYSES

AREA/SAMPLE No.	TOC (%)	ORGANICS (µg/g)										
		PCB 1254	PCB 1260	2B	3B	5B	13B	18B	26B	31B	44B	45B
CHROMATE POND												
SS020785-125	1.9	<1.0	<1.0	ND	ND	ND	2.9	ND	ND	1.6	1.1	1.4
SS020785-127	3.6	<1.0	<1.0	ND	ND	ND	3.5	ND	ND	.7	.6	1.0
CLASS. BURIAL GRND												
SS020485-42	1.2	<1.0	<1.0	ND	ND	ND	.1	ND	ND	.3	ND	.4
SS022885-216	1.8	<1.0	<1.0	.1	ND	ND	ND	ND	1.0	ND	ND	ND
CLINCH RIVER												
SS013185-21	.5	<1.0	<1.0	ND	ND	ND	1.9	ND	ND	ND	ND	ND
SS021585-165L	2.6	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
SS021585-161R	.8	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
WB021485[0-4C	2.5	<1.0	<1.0	ND	ND	ND	3.6	ND	ND	.1	.1	.1
CLINCH RIVER TRIB 1												
SS012485-10	3.8	<1.0	<1.0	ND	ND	ND	8.1	ND	ND	.2	ND	ND
EAST FORK POPLAR CR												
SS022185-212	3.1	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
SS022285-138	3.9	<1.0	<1.0	ND	ND	1.3	4.7	1.9	ND	3.1	2.8	4.0
EF021585(0-4)	1.4	<1.0	<1.0	ND	ND	ND	.7	ND	.1	.3	.1	.4
K1007B (PC TRIB 4)												
SS020485-45	ND	12.6	<1.0	.7	ND	ND	.5	.5	.2	.9	.3	1.2
SS020485-46	1.4	3.0	<1.0	.2	ND	ND	ND	ND	ND	ND	ND	ND
K1700 STREAM												
SS020485-35L	4.6	<1.0	<1.0	ND	2.4	ND	ND	ND	.1	3.0	2.4	2.5
SS011085-5R	7.3	ND	ND	ND	.3	ND	13.9	ND	.1	.4	.4	.2
SS020485-49	4.1	<1.0	<1.0	ND	ND	ND	8.2	ND	.7	.7	1.1	1.2
POPLAR CREEK												
SS021585-138R	.9	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
SS020685-52R	3.8	<1.0	<1.0	ND	.1	ND	.6	ND	.1	.4	.3	.1
SS020685-111R	2.8	<1.0	<1.0	ND	.2	ND	.7	ND	ND	.3	.3	.1
SS020685-65L	3.2	<1.0	<1.0	ND	.2	ND	.4	ND	.3	.3	.3	ND
SS020685-72R	3.1	<1.0	<1.0	ND	.1	ND	.6	ND	ND	.3	.3	.1
SS020785-79L	2.9	<1.0	<1.0	ND	.2	ND	.8	ND	.1	ND	.3	ND
SS020785-120L	3.3	<1.0	<1.0	ND	ND	.5	.8	.7	.1	1.2	.5	1.5
SS020785-117	2.3	<1.0	<1.0	ND	ND	ND	1.8	ND	ND	2.6	2.7	2.4
SS020785-115	2.9	<1.0	5.0	ND	ND	2.1	ND	3.0	.2	9.8	6.6	12.1
SS020685-113L	3.1	<1.0	<1.0	ND	.2	ND	.7	ND	.1	.3	.3	.1
SS021185-154R	2.7	<1.0	<1.0	ND	.4	ND	96.7	ND	.1	.5	.7	.8
PC022085[0-4C	2.6	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
SS021185-155R	2.4	<1.0	<1.0	ND	.5	ND	1.2	ND	ND	1.1	1.0	1.6
POWERHOUSE												
SS013185-29	2.4	<1.0	<1.0	ND	.1	ND	2.6	ND	.1	.3	.4	.1

RESULTS OF GC-MS ANALYSES

AREA/SAMPLE No.	TOC (%)	ORGANICS ($\mu\text{g/g}$)										
		PCB 1254	PCB 1260	2B	3B	5B	13B	18B	26B	31B	44B	45B
POWERHOUSE SS022185-207	2.8	<1.0	<1.0	ND	ND	ND	1.2	ND	ND	.4	.2	.5

ND = Not Detected

ORGANIC COMPOUND CODES ARE AS FOLLOWS:

TOC---Total Organic Carbon
2B----Acenaphthylene
3B----Anthracene
5B----Benzo(a)Anthracene
13B---Bis(2-ethylhexyl)phthalate
18B---Chrysene
26B---di-N-Butylphthalate
31B---Fluoranthene
44B---Phenanthrene
45B---Pyrene

APPENDIX E
SEDIMENT CORE DATA

EAST FORK POPLAR CREEK SEDIMENT CORE (021585)

SAMPLE (cm)	Cs-137 (pCi/g)	Co-60 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Ra-226 (pCi/g)
0-2	4.8 ± 0.1	1.9 ± 0.1	8.5 ± 1.0	0.3 ± 0.1	0.9 ± 0.1
2-4	3.7 ± 0.1	1.3 ± 0.1	6.0 ± 3.8	0.4 ± 0.1	0.7 ± 0.1
4-6	2.0 ± 0.1	17.9 ± 0.3	7.0 ± 3.8	0.5 ± 0.1	0.8 ± 0.1
6-8	1.4 ± 0.1	0.4 ± 0.1	9.9 ± 1.6	0.7 ± 0.1	0.6 ± 0.1
8-10	1.3 ± 0.1	0.3 ± 0.1	25.7 ± 2.0	1.4 ± 0.1	0.7 ± 0.1
10-12	0.4 ± 0.1	0.4 ± 0.1	56.9 ± 1.8	2.7 ± 0.1	0.9 ± 0.1
12-14	0.2 ± 0.1	0.1 ± 0.1	74.4 ± 1.9	3.7 ± 0.3	0.9 ± 0.1
14-16	0.2 ± 0.0	0.1 ± 0.0	31.4 ± 1.7	1.6 ± 0.1	1.0 ± 0.1
16-18	0.1 ± 0.0	0.1 ± 0.1	16.5 ± 1.1	0.9 ± 0.2	0.9 ± 0.1
18-20	0.1 ± 0.1	ND	16.3 ± 1.1	0.7 ± 0.1	1.1 ± 0.1
20-22	0.1 ± 0.0	ND	4.8 ± 1.4	0.5 ± 0.1	1.2 ± 0.1
22-24	ND	ND	14.5 ± 1.1	0.6 ± 0.1	1.1 ± 0.1
24-26	0.05±0.01	0.02±0.01	2.7 ± 0.9	0.2 ± 0.1	1.0 ± 0.1
26-28	0.05±0.01	ND	1.9 ± 0.7	ND	0.8 ± 0.1
28-30	ND	ND	3.2 ± 1.0	ND	0.9 ± 0.1
30-32	ND	ND	ND	ND	0.8 ± 0.1
32-34	0.03±0.01	ND	ND	ND	1.0 ± 0.1
34-36	0.02±0.01	ND	ND	ND	1.2 ± 0.1
36-38	ND	ND	ND	0.07±0.04	1.0 ± 0.1
38-40	ND	ND	ND	ND	1.2 ± 0.1
40-44	ND	ND	ND	ND	1.2 ± 0.1
44-48	ND	ND	ND	ND	1.2 ± 0.1
48-52	0.03±0.01	ND	1.2 ± 0.6	0.2 ± 0.1	1.2 ± 0.1
52-56	ND	ND	ND	ND	0.7 ± 0.1
56-60	0.12±0.01	0.05±0.01	2.4 ± 1.7	0.1 ± 0.1	0.6 ± 0.1
60-64	ND	ND	ND	ND	0.8 ± 0.1
64-68	0.01±0.01	ND	0.7 ± 0.3	ND	0.6 ± 0.1
68-72	ND	ND	ND	ND	0.5 ± 0.1
72-76	ND	ND	ND	ND	0.6 ± 0.1
88-92	ND	ND	ND	ND	0.8 ± 0.2

EAST FORK POPLAR CREEK SEDIMENT CORE (021585)

SAMPLE DEPTH (cm)	ORGANICS (µg/g)										METALS (µg/g)										
	TOC (%)	PCB (1254)	PCB (1260)	38	58	138	188	268	318	448	458	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
0-4	1.4	ND	ND	ND	ND	0.7	ND	0.1	0.3	0.1	0.4	4.9	ND	ND	49	40	21	33	26	110	130
4-8	2.5	—	—	—	—	—	—	—	—	—	—	ND	ND	1.9	48	25	16	31	29	ND	100
8-12	3.7	—	—	—	—	—	—	—	—	—	—	4.4	6.8	3.3	82	87	22	66	70	ND	220
12-16	1.7	ND	ND	ND	ND	2.5	ND	0.3	1.2	0.3	1.5	6.3	ND	ND	78	92	39	63	45	150	170
16-20	3.0	—	—	—	—	—	—	—	—	—	—	5.6	ND	1.0	62	680	24	89	58	31	220
20-24	1.5	ND	ND	ND	ND	12.1	ND	0.1	3.8	1.2	4.8	7.0	ND	ND	37	98	6.8	48	16	180	110
24-28	1.2	—	—	—	—	—	—	—	—	—	—	12.0	ND	ND	34	87	5.6	40	14	230	98
28-32	1.9	ND	ND	ND	ND	ND	ND	0.3	ND	ND	ND	3.5	ND	ND	36	54	2.1	33	10	99	100
32-36	4.6																				
36-40	5.4																				
40-44	2.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.3	ND	ND	25	9	0.5	24	11	140	59
44-48	1.5	ND	ND	ND	ND	ND	ND	0.3	1.9	ND	2.4	2.3	ND	ND	26	22	ND	29	9	180	62
48-52	1.2																				
52-56	2.3																				
56-60	2.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	21	19	ND	27	8	110	65
60-64	2.4																				
64-68	1.3																				
68-72	0.7																				
72-76	0.6																				
76-80	0.2	ND	ND	ND	ND	6.8	ND	ND	ND	ND	ND	ND	ND	ND	53	ND	ND	15	15	190	22

ORGANIC COMPOUND CODES:

TOC—Total Organic Carbon
 38 ---Anthracene
 48 ---Benzo(a)Anthracene
 138---Bis(2-ethylhexyl)phthalate
 188---Chrysene
 268---di-n-Butylphthalate
 318---Fluoranthene
 448---Phenanthrene
 458---Pyrene

LOWER POPLAR CREEK SEDIMENT CORE (021485)

SAMPLE (cm)	Cs-137 (pCi/g)	CO-60 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Ra-226 (pCi/g)
0-2	1.9 ± 0.1	0.6 ± 0.1	4.5 ± 1.6	0.5 ± 0.1	1.3 ± 0.1
2-4	1.8 ± 0.1	0.7 ± 0.1	ND	ND	1.3 ± 0.1
4-6	1.7 ± 0.1	0.8 ± 0.1	ND	ND	1.1 ± 0.1
6-8	1.9 ± 0.1	1.8 ± 0.2	3.2 ± 2.8	ND	1.6 ± 0.2
8-10	1.7 ± 0.1	0.5 ± 0.1	ND	ND	1.4 ± 0.1
10-12	1.2 ± 0.1	0.6 ± 0.1	3.1 ± 0.1	0.3 ± 0.1	1.2 ± 0.1
12-14	1.2 ± 0.1	0.2 ± 0.1	1.9 ± 1.9	0.4 ± 0.1	1.1 ± 0.2
14-16	1.1 ± 0.1	0.1 ± 0.0	ND	ND	1.3 ± 0.2
16-20	1.3 ± 0.1	0.4 ± 0.1	5.3 ± 1.2	0.2 ± 0.1	1.2 ± 0.1
20-24	1.1 ± 0.1	0.2 ± 0.1	5.0 ± 3.8	0.4 ± 0.1	1.3 ± 0.1
24-28	1.0 ± 0.1	ND	7.7 ± 1.8	0.5 ± 0.1	1.2 ± 0.1
28-32	1.2 ± 0.1	0.05±0.02	7.0 ± 1.4	0.4 ± 0.1	1.3 ± 0.1
32-36	1.0 ± 0.1	0.03±0.01	9.9 ± 1.0	0.5 ± 0.1	1.4 ± 0.1
36-40	0.9 ± 0.1	ND	8.1 ± 1.3	0.5 ± 0.1	1.2 ± 0.1
40-44	1.1 ± 0.1	0.04±0.02	9.4 ± 1.1	0.5 ± 0.1	1.3 ± 0.1
44-48	0.9 ± 0.1	ND	6.9 ± 1.8	0.5 ± 0.2	1.2 ± 0.1
48-52	1.0 ± 0.1	ND	9.1 ± 1.1	0.5 ± 0.2	1.4 ± 0.1
52-56	1.3 ± 0.1	ND	7.1 ± 1.2	0.5 ± 0.2	1.0 ± 0.1
56-60	2.7 ± 0.1	0.05±0.02	13.8 ± 2.0	1.1 ± 0.1	1.2 ± 0.1
60-64	4.9 ± 0.1	0.11±0.02	16.7 ± 1.6	0.9 ± 0.1	1.3 ± 0.1
64-68	2.9 ± 0.1	0.07±0.02	12.1 ± 1.2	1.0 ± 0.3	1.3 ± 0.1
68-72	2.1 ± 0.1	0.04±0.01	10.6 ± 1.3	1.1 ± 0.2	1.3 ± 0.1
72-76	4.8 ± 0.1	0.12±0.02	24.1 ± 1.9	1.8 ± 0.2	1.5 ± 0.1
76-80	5.0 ± 0.1	0.08±0.04	14.6 ± 3.5	2.6 ± 0.5	1.5 ± 0.1
80-88	6.3 ± 0.1	0.10±0.02	20.2 ± 1.0	1.7 ± 0.1	1.3 ± 0.1
88-96	2.2 ± 0.1	0.07±0.01	4.0 ± 0.9	0.4 ± 0.1	3.0 ± 0.1
96-104	1.3 ± 0.1	0.07±0.01	2.9 ± 0.9	0.2 ± 0.1	3.8 ± 0.1
104-112	2.8 ± 0.1	0.05±0.02	3.2 ± 1.2	0.3 ± 0.1	3.6 ± 0.1
112-120	2.7 ± 0.1	0.06±0.01	3.1 ± 0.8	0.2 ± 0.1	3.5 ± 0.1
120-128	4.3 ± 0.1	0.09±0.01	3.8 ± 0.8	0.1 ± 0.1	3.6 ± 0.1

WATTS BAR RESERVOIR SEDIMENT CORE (022085)

SAMPLE DEPTH (cm)	ORGANICS (ug/g)					METALS (ug/g)															
	TDC (%)	PCB (1254)	PCB 3B	5B	(1260)	13B	18B	26B	31B	44B	45B	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
0-4	2.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4	ND	ND	27	43	3.1	42	15	130	120
4-8	2.5	--	--	--	--	--	--	--	--	--	--	ND	11	0.8	28	34	1.7	40	27	ND	120
8-12	2.2	--	--	--	--	--	--	--	--	--	--	ND	9.5	0.8	28	28	2.2	38	24	ND	110
12-16	2.0	ND	ND	ND	ND	ND	ND	ND	0.1	ND	0.2	0.9	ND	ND	27	21	3.9	34	18	130	91
16-20	2.0	--	--	--	--	--	--	--	--	--	--	ND	ND	ND	28	22	2.8	30	23	35	80
20-24	2.2	ND	ND	ND	ND	ND	ND	0.2	ND	ND	0.1	ND	ND	0.5	30	18	2.2	28	22	ND	87
24-28	2.1	--	--	--	--	--	--	--	--	--	--	ND	5.9	0.7	36	22	3.1	33	23	ND	100
28-32	2.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	ND	ND	44	23	6.6	43	14	150	110
32-34	---	--	--	--	--	--	--	--	--	--	--	ND	6.1	0.6	49	37	5.9	42	26	ND	150
34-36	---	--	--	--	--	--	--	--	--	--	--	ND	ND	0.7	51	33	6.3	43	26	ND	160
36-40	2.3	--	--	--	--	--	--	--	--	--	--	ND	ND	ND	46	47	6.5	41	25	ND	120
40-44	2.6	ND	0.2	ND	0.2	ND	0.1	0.4	0.1	0.5	1.5	ND	ND	ND	51	30	25.0	58	20	190	130
44-48	2.7	ND	ND	ND	ND	ND	ND	ND	ND	0.2	0.2	ND	ND	ND	38	36	16.7	53	28	47	120
48-52	2.7	--	--	--	--	--	--	--	--	--	--	ND	10	0.8	24	22	3.6	30	26	ND	100
52-56	2.7	--	--	--	--	--	--	--	--	--	--	ND	6.8	ND	28	15	1.3	30	26	ND	100
56-60	2.9	ND	ND	ND	ND	0.2	ND	ND	0.1	0.1	0.6	ND	ND	ND	22	13	1.0	27	13	140	80
60-64	2.9																				
64-68	2.9																				
68-72	2.3	ND	ND	ND	ND	ND	ND	0.2	ND	0.1	0.2	ND	ND	ND	29	27	ND	30	29	49	97
72-76	2.3																				
76-80	---	ND	ND	5.6	3.8	ND	5.4	ND	ND	5.4	12.0	ND	ND	0.6	23	21	ND	17	130	ND	150

ORGANIC COMPOUND CODES:

TUC	---Total Organic Carbon
3B	---Anthracene
4B	---Benzo(a)Anthracene
13B	---Bis(2-ethylhexyl)phthalate
18B	---Chrysene
26B	---di-n-Butylphthalate
31B	---Fluoranthene
44B	---Phenanthrene
45B	---Pyrene

WATTS BAR RESERVOIR SEDIMENT CORE (022085)

SAMPLE (cm)	Cs-137 (pCi/g)	Co-60 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Ra-226 (pCi/g)
0-2	10.9 ± 0.3	0.7 ± 0.1	2.0 ± 1.2	ND	1.2 ± 0.3
2-4	8.6 ± 0.3	0.8 ± 0.1	ND	ND	1.6 ± 0.2
4-6	7.3 ± 0.2	0.7 ± 0.1	ND	ND	1.2 ± 0.2
6-8	7.9 ± 0.1	0.7 ± 0.1	ND	ND	1.2 ± 0.2
8-10	6.7 ± 0.2	0.7 ± 0.1	0.4 ± 0.9	0.1 ± 0.1	1.3 ± 0.1
10-12	6.9 ± 0.1	0.5 ± 0.1	ND	ND	1.2 ± 0.1
12-14	6.7 ± 0.2	0.3 ± 0.1	ND	ND	0.9 ± 0.1
14-16	7.8 ± 0.2	0.3 ± 0.1	ND	ND	1.1 ± 0.1
16-18	8.3 ± 0.2	0.2 ± 0.1	ND	ND	1.2 ± 0.2
18-20	7.1 ± 0.1	0.2 ± 0.0	ND	ND	1.1 ± 0.1
20-22	10.5 ± 0.2	0.2 ± 0.1	3.2 ± 1.2	0.2 ± 0.1	1.1 ± 0.2
22-24	10.4 ± 0.1	0.3 ± 0.0	4.0 ± 1.3	0.1 ± 0.1	1.1 ± 0.1
24-26	12.8 ± 0.2	0.4 ± 0.1	3.4 ± 1.8	0.2 ± 0.1	1.2 ± 0.1
26-28	14.5 ± 0.2	0.4 ± 0.1	1.9 ± 0.9	0.1 ± 0.1	1.2 ± 0.1
28-30	20.7 ± 0.4	0.7 ± 0.1	6.3 ± 2.3	ND	1.1 ± 0.2
30-32	21.1 ± 0.3	0.5 ± 0.1	5.3 ± 1.2	ND	1.4 ± 0.2
32-34	23.6 ± 0.3	0.4 ± 0.1	2.3 ± 0.8	ND	1.0 ± 0.2
34-36	25.7 ± 0.4	0.5 ± 0.1	3.2 ± 0.9	0.2 ± 0.1	1.4 ± 0.2
36-38	31.4 ± 0.4	0.5 ± 0.1	6.2 ± 1.6	ND	1.7 ± 0.2
38-40	42.8 ± 0.5	0.4 ± 0.1	1.6 ± 1.0	ND	1.7 ± 0.2
40-44	71.4 ± 0.6	0.6 ± 0.1	5.9 ± 0.8	ND	0.9 ± 0.3
44-48	46.4 ± 0.5	0.6 ± 0.1	2.9 ± 1.1	ND	1.2 ± 0.3
48-52	31.3 ± 0.4	0.1 ± 0.1	6.2 ± 2.0	ND	1.3 ± 0.2
52-56	25.9 ± 0.4	ND	1.2 ± 0.8	ND	1.1 ± 0.2
56-60	14.4 ± 0.3	ND	4.5 ± 1.0	ND	1.1 ± 0.2
60-64	19.7 ± 0.3	ND	1.9 ± 0.9	ND	1.5 ± 0.2
64-68	13.7 ± 0.3	ND	1.9 ± 0.9	0.2 ± 0.1	1.2 ± 0.1
68-72	2.3 ± 0.1	ND	3.4 ± 1.0	0.2 ± 0.1	1.3 ± 0.1
72-76	0.7 ± 0.1	ND	1.5 ± 0.8	ND	1.3 ± 0.1
76-80	0.2 ± 0.1	ND	ND	ND	1.1 ± 0.1

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